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(54) **INFORMATION PROCESSING DEVICE, INFORMATION PROCESSING METHOD, AND CONTROL PROGRAM**

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DISPOSITIF DE TRAITEMENT D'INFORMATIONS, PROCÉDÉ DE TRAITEMENT D'INFORMATIONS ET PROGRAMME DE COMMANDE

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## Description

### Technical Field

**[0001]** The present invention relates to an information processing device for monitoring the state of a pit provided in a waste incineration plant.

### Background Art

**[0002]** A waste incineration plant includes a pit for temporarily storing waste brought in by a garbage truck. The waste inside the pit is stirred with use of a crane and is then transferred to an incinerator for incineration. The stirring is carried out to homogenize waste to be transferred to the incinerator, and is an important process for stable waste combustion.

**[0003]** Improving a method for stirring waste desirably involves first accurately determining the state of how the waste inside a pit has been stirred. Patent Literature 1 below, for example, discloses a waste stirring evaluating device. The waste stirring evaluating device, on the basis of movement of a garbage truck or crane, computes the shape of deposition of waste or shape of a dented portion of waste, and also calculates the number of times of stirring for each layer of the waste deposited inside the pit. The waste stirring evaluating device then determines an evaluation value on the basis of the number of times of stirring calculated for each place inside the pit, and computes a crane controlling instruction.

**[0004]** JP 2006 027783 A relates to a control device of an automatic crane for a garbage disposal plant including two cameras arranged with the predetermined interval in a crane girder of the crane at positions possible to take a picture of the garbage pit, a garbage height measuring means for measuring height of the garbage piled inside the garbage pit by utilizing stereo disparity of the two cameras, and a garbage height memory means for storing information about garbage height measured by the garbage height measuring means as a garbage height map. JP H02 62397 relates to a garbage disposal crane control device for loading and unloading garbage including earth and sand into and from an actual pit while controlling the garbage disposal crane based on the garbage mountain level data stored in the garbage mountain level storage device of the internal level management device. JP 2006 044904 A relates to a control device of an automatic crane for a refuse disposal works including two cameras arranged in a girder of the crane with the predetermined interval to take photographs of a refuse pit, a refuse height measuring means for measuring height of the refuse piled inside the refuse pit by using a visual difference by stereo-view of the two cameras, and a refuse height memory means for storing refuse height information as a refuse height map.

### Citation List

#### [Patent Literature]

**[0005]** [Patent Literature 1]
Japanese Patent Application Publication, Tokukai, No. 2010-275064 (Publication date: December 9, 2010)

### Summary of Invention

#### Technical Problem

**[0006]** Conventional art such as the above unfortunately fails to allow movement of waste to be determined accurately. Specifically, conventional art involves determining the state inside the pit (for example, the height of waste or state of how the waste has been stirred) on the basis of movement of a crane or the like (for example, grabbing, dropping, and the length of a crane rope during a grabbing operation). This means that the state can be determined only of an area in which the crane has moved. An area in which the crane does not move frequently thus gives rise to a very large error. Conventional art, as a result, involves an issue of failing to determine the state inside a pit accurately.

**[0007]** An aspect of the present invention has an object to provide, for example, an information processing device capable of accurately determining the state inside a pit.

#### Solution to Problem

**[0008]** In order to attain the above object, an information processing device in accordance with an aspect of the present invention is defined in claim 1.

**[0009]** In order to attain the above object, an information processing method in accordance with an aspect of the present invention is defined in claim 6. Further advantageous embodiments are defined in dependent claims.

#### Advantageous Effects of Invention

**[0010]** An aspect of the present invention advantageously allows the state inside a pit to be determined accurately.

### Brief Description of Drawings

**[0011]**

Fig. 1 is a block diagram illustrating an example configuration of a main part of a pit monitoring device.
Fig. 2 is a cross-sectional diagram schematically illustrating the structure of a waste incineration plant including a pit.
Fig. 3 is a drawing of a pit and hoppers as viewed from above.
Fig. 4 is a diagram illustrating a specific example of

the data structure of bringing-in data.

(a) and (b) of Fig. 5 are each a diagram illustrating a specific example of the data structure of measurement data.

Fig. 6 is a diagram illustrating a specific example of the data structure of crane data.

(a) and (b) of Fig. 7 are each a diagram illustrating a specific example of the data structure of event information.

Fig. 8 is a diagram illustrating a specific example of the data structure of deposition information.

Fig. 9 is a diagram illustrating a specific example of the data structure of deposition information.

Fig. 10 is a flowchart illustrating the flow of an event determining process that an event determining section carries out.

Fig. 11 is a flowchart illustrating the flow of a deposition information generating process that a deposition information generating section carries out.

Fig. 12 is a diagram illustrating another example of the data structure of measurement data.

Description of Embodiments

Embodiment 1

**[0012]** The following description will discuss an embodiment of the present invention in detail. The present invention relates to, for example, an information processing device for monitoring the state of a pit at a waste incineration plant. The description below thus first deals with a waste incineration plant and a pit provided therein with reference to Fig. 2.

<Overview of waste incineration plant>

**[0013]** Fig. 2 is a cross-sectional diagram schematically illustrating the structure of a waste incineration plant including a pit. The waste incineration plant 100 in accordance with Embodiment 1 of the present invention, as illustrated in Fig. 2, includes a waste pre-acceptance measurement facility 1, a waste acceptance facility 2, and waste incinerators 3. The waste incineration plant 100 also includes a control room 8 in which an operator, for example, monitors the above facilities or operates a crane 5 manually.

**[0014]** The waste pre-acceptance measurement facility 1 is configured to (i) carries out measurement before the waste is brought to the waste acceptance facility 2 and thereby (ii) generate various pieces of data on the waste. The waste acceptance facility 2 is configured to temporarily store waste brought in by a plurality of garbage trucks Q. The waste incinerators 3 are present next to the waste acceptance facility 2, and are configured to incinerate waste. The waste incinerators 3 are a pair of facilities arranged next to each other in the X direction (that is, the direction orthogonal to the surface of Fig. 2). The control room 8 contains a control system laid therein for (i) communicating with the individual facilities and thereby (ii) centrally controlling the waste incineration plant 100. The control room 8 is provided for a user to, for example, monitor the individual facilities of the waste incineration plant 100 (in particular, the state of the inside of the pit 21) or operate the crane 5 manually.

**[0015]** The waste incineration plant 100 in accordance with Embodiment 1 may be newly built to serve as such or may be an existing waste incineration plant. The control system includes individual devices that are communicable with each other over a network and with other devices present remotely from the control room 8 over the network.

(Waste pre-acceptance measurement facility 1)

**[0016]** The waste pre-acceptance measurement facility 1 is present upstream of the waste acceptance facility 2, that is, near the entrance of the waste incineration plant 100. The waste pre-acceptance measurement facility 1 includes a weighing device 11 and a waste type registering device 12.

**[0017]** The weighing device 11 is, for instance, buried in a road surface, and is configured to weigh a garbage truck Q that has stopped thereon. The weighing device 11 subtracts the weight of the garbage truck Q from the measured weight to calculate the weight of the waste loaded on the garbage truck Q. The weighing device 11 transmits, to a pit monitoring device 4 (information processing device), waste weight data indicative of the calculated weight of waste.

**[0018]** The waste type registering device 12 is configured to register the type (hereinafter referred to as "waste type") of waste loaded on a garbage truck Q. The waste type registering device 12 of the present embodiment is, for instance, configured to transmit, to the pit monitoring device 4, waste type data indicative of whether the waste loaded is a combustible waste or incombustible waste.

**[0019]** The waste type may be registered with the waste type registering device 12 by, for example, a staffer who manages the waste pre-acceptance measurement facility 1. In a case where each garbage truck Q always loads waste of a particular type, the waste type registering device 12 may determine the waste type on the basis of, for example, the model or vehicle number of the garbage truck Q. In a case where the type of waste collected is fixed according to the day of the week and the area, the waste type registering device 12 may determine the waste type on the basis of (i) the day of the week on which the waste was brought in and (ii) the area in which the garbage truck Q collected the waste. The parameters such as the car model, vehicle number, day of the week on which waste is brought (date and time), and collection area may be entered into the waste type registering device 12 by, for example, a staffer, or may be obtained automatically by the waste type registering device 12.

(Waste acceptance facility 2)

**[0020]** The waste acceptance facility 2, as illustrated in Fig. 2, includes a pit 21, hoppers 22, and a building 23. The building 23 stands over the pit 21 and the hoppers 22. The pit 21 serves to store waste brought in by a garbage truck Q. The hoppers 22 are adjacent to the pit 21, and serve to supply waste inside the pit 21 into the waste incinerators 3. The hoppers 22 are, similarly to the waste incinerators 3, a pair of hoppers arranged next to each other in the X direction, and correspond respectively to the pair of waste incinerators 3. The pit 21 is equipped with one or more bring-in doors 24 on the side of the entrance of the building 23, that is, on the side of the Y1 direction.

**[0021]** The building 23 is equipped with a crane 5 at a portion above the pit 21 and the hoppers 22 (that is, in the Z1 direction), for example, near the ceiling of the building 23. The crane 5 includes (i) a girder 51 movable in the X direction and (ii) a transverse carriage 52 present above the girder 51 and movable in the Y direction. The crane 5 also includes a bucket 53 for grabbing waste inside the pit 21, a wire 54 connecting the bucket 53 and the transverse carriage 52 with each other, and a winder 55 for winding and unwinding the wire 54 to lift and lower the bucket 53 in the height direction (that is, in the Z direction). The winder 55 is provided on the transverse carriage 52, for instance.

**[0022]** The crane 5 is configured to carry out a stirring operation of stirring waste and a taking-out operation of taking out waste into a waste incinerator 3. The stirring operation refers to an operating of stirring waste inside the pit 21 by grabbing waste inside the pit 21 (grabbing) and then dropping the grabbed waste back into the pit 21 (dropping) as illustrated in Fig. 2. The stirring operation allows waste inside the pit 21 to be homogeneous (that is, uniform in terms of composition of the respective proportions of different waste types). The taking-out operation refers to an operation of taking out waste from the pit 21 into a waste incinerator 3 by grabbing waste and then putting the waste into a hopper 22 and then into a waste incinerator 3 (putting-in). This allows the waste put in to be incinerated.

(Waste incinerators 3)

**[0023]** The waste incinerators 3 each include a combustion chamber 31, a waste guiding path 32, an ash outlet 33, a flue 34, and a steam turbine 35. The combustion chamber 3 1 is, for example, a stoker-type combustion chamber. The waste guiding path 32 is present on the side of the front end (that is, on the Y1 side) of the combustion chamber 31, and is connected with the corresponding hopper 22. The waste put in from the hopper 22 is guided through the corresponding waste guiding path 32 into the corresponding combustion chamber 31. The ash outlet 33 is present on the side of the back end (that is, on the Y2 side) of the combustion chamber 31. Incinerated ash resulting from incineration of waste inside the combustion chamber 31 is discharged from the combustion chamber 31 through the ash outlet 33.

**[0024]** The flue 34 is present on the upper back side (that is, on the Z1-Y2 side) of the combustion chamber 31. The flue 34 is equipped with a steam turbine 35 configured to (i) heat and evaporate supplied water with use of heat of exhaust gas flowing through the flue 34 and thereby (ii) recover thermal energy from the exhaust gas. In order for the steam turbine 35 to recover thermal energy from exhaust gas efficiently, stable combustion should desirably be carried out continuously.

**[0025]** The waste incinerators 3 may each be equipped with various sensors such as a camera (not shown) for monitoring the inside of the waste incinerator 3. Data obtained by such sensors (for example, an image captured by the camera or data on the amount of steam at the steam turbine 35) is transmitted to an incinerator monitoring device 7 at the control room 8.

(Control room 8)

**[0026]** The control system laid in the control room 8 includes (i) a pit monitoring device 4 that functions as an information processing device in accordance with the present invention and (ii) a height measuring device 13 (three-dimensional measuring device). The control system may further include, for example, a crane PLC (programmable logic controller) 14 and an incinerator monitoring device 7.

**[0027]** The pit monitoring device 4 is configured to (i) monitor occurrence of different events inside the pit 21 and (ii) determine the state of the pit 21 on the basis of the monitoring result. Specifically, the pit monitoring device 4 is configured to, for instance, (i) obtain data related to "bringing-in" from the waste pre-acceptance measurement facility 1, (ii) obtain data related to the height of waste inside the pit 21 from the height measuring device 13, and/or (iii) obtain data related to the crane 5 from the crane PLC 14. The pit monitoring device 4 then (i) analyzes the obtained data to detect occurrence of an event in the pit 21 and (ii) identifies the event detected.

**[0028]** The height measuring device 13 is configured to measure the respective heights of waste at different positions inside the pit 21. The height measuring device 13 of the present embodiment is, as an example, a three-dimensional scanner including a laser sensor mounted therein. The height measuring device 13 is placed at a position inside the waste acceptance facility 2 which position allows the height measuring device 13 to overlook the entire pit 21.

**[0029]** The crane PLC 14 functions to control, in response to an instruction from the pit monitoring device 4 or incinerator monitoring device 7, how the crane 5 is to be driven. The crane PLC 14, for instance, causes the crane 5 to carry out a stirring operation (that is, grabbing and dropping) or taking-out operation (that is, grabbing and putting-in). Specifically, the crane PLC 14 controls

(i) the movement of the girder 51 and transverse carriage 52, (ii) the winding and unwinding by the winder 55, and (iii) opening and closing of the bucket 53.

**[0030]** For the above control of the movement, the crane PLC 14 moves the girder 51 and transverse carriage 52 so that the bucket 53 is placed at a position specified with coordinates on an X-Y plane of the pit 21 as instructed by the pit monitoring device 4.

**[0031]** The crane PLC 14 may be configured to record the path of movement of the crane 5. The crane PLC 14 may further include a waste weight detecting section (not shown) for detecting the weight of waste grabbed by the bucket 53 of the crane 5. The crane PLC 14 may be configured to regularly transmit, to the pit monitoring device 4, information on the recorded movement path and the detected waste weight as crane information.

**[0032]** The incinerator monitoring device 7 determines, on the basis of various pieces of data obtained by various sensors present at each waste incinerator 3, whether to put waste into the waste incinerator 3. In a case where the incinerator monitoring device 7 has determined that waste needs to be put in, the incinerator monitoring device 7 causes the pit monitoring device 4 to instruct the crane 5 to take out waste. The incinerator monitoring device 7 may be configured to, in correspondence with the type of waste put in the waste incinerator 3, control combustion of the waste put in the waste incinerator 3.

(Pit 21)

**[0033]** The following description will discuss the pit 21 in detail with reference to Figs. 2 and 3. Fig. 3 is a drawing of the pit 21 and the hoppers 22 as viewed from above. As illustrated in Fig. 3, the pit 21 is in the shape of a cuboid box having a bottom on an X-Y plane. The pit 21 is virtually segmented by the pit monitoring device 4 into a plurality of areas P on an X-Y plane. The pit 21 illustrated in the drawing as an example is virtually segmented into 80 (= 5 × 16) areas P(i, j) (where i is a to e, and j is 1 to 16). The pit 21 illustrated in the drawing as an example is segmented in a landscape orientation as viewed from, for example, the control room 8 in such a manner that the i rows are arranged next to each other in the Y direction and that the j columns are arranged next to each other in the X direction.

**[0034]** The pit 21 is illustrated as being segmented with a pitch that causes the pit 21 to be segmented into approximately 5 × 16 cells for simple illustration. The pit 21 of the present embodiment is, however, segmented into areas P in such a manner that the areas P each have a pitch used when the height measuring device 13 measures the respective heights of waste at different positions on an X-Y plane of the pit 21 (that is, the areas P are each in the shape of a square with sides measuring several centimeters). The pit 21 may be segmented into approximately 100 × 320 cells, for example.

**[0035]** The pit 21 is equipped with one or more bring-in doors 24 on the side of the Y1 direction. The example illustrated in Fig. 3 includes six bring-in doors 24. The bring-in doors 24 each allow a garbage truck Q (see Fig. 2) to bring waste loaded thereon into the pit 21. The pair of hoppers 22 are present on the far side of the pit 21 as viewed from the entrance of the building 23, that is, on the side of the Y2 direction, in correspondence with the respective waste incinerators 3.

**[0036]** The description of the present embodiment uses, as an example, (i) the term "acceptance area" (that is, an area for accepting waste brought in) to refer to the area of the d row and e row (which are close to the bring-in doors 24) and (ii) the term "stirring area" to refer to the a row and b row (which are close to the hoppers 22).

**[0037]** In a case where waste on a garbage truck Q has been brought into the pit 21, the pit monitoring device 4 recognizes the bringing-in of the waste. The pit monitoring device 4 may alternatively be configured to recognize bringing-in of waste on the basis of receipt of waste weight data transmitted from the weighing device 11 or waste type data transmitted from the waste type registering device 12. The pit monitoring device 4 may alternatively be configured to recognize bringing-in of waste on the basis of data on opening and closing of a bring-in door 24 which data has been transmitted from the waste pre-acceptance measurement facility 1. The pit monitoring device 4 may alternatively be configured to recognize bringing-in of waste on the basis of a change in the height of a waste heap in the pit 21. The pit monitoring device 4 may alternatively be configured to determine, on the basis of a combination of the above, whether waste has been brought in.

(Events)

**[0038]** As described above, the height of a waste heap in the pit 21 can be changed as a result of any of the following events:

"Bringing-in": A garbage truck Q newly bringing waste into the pit 21 through a bring-in door 24
"Stirring" (that is, grabbing and dropping): The crane 5 grabbing waste inside the pit 21 and then dropping the waste back into the pit 21 from a certain height
"Taking-out" (that is, grabbing and putting in): The crane 5 grabbing waste inside the pit 21 and then putting the waste into another facility (for example, a hopper 22 or waste incinerator 3) outside the pit 21

**[0039]** Example events that cause the height of a waste heap to change include a "heap slide" in addition to the above. A "heap slide" refers to a mass of waste at a high position in a waste heap falling down without artificial intervention of a crane or the like. A heap slide is in most cases in no causal relationship with occurrence of any of the above three events. A heap slide, of which a person is unable to control occurrence or prevention, differs in nature from the above three events, each of which a person is able to cause intentionally.

**[0040]** The pit monitoring device 4 of the present embodiment is capable of (i) recognizing occurrence of either of a controllable event (which a person is able to cause intentionally) or an uncontrollable event (which can occur naturally) and (ii) identifying the event having occurred.

<Configuration of pit monitoring device 4>

**[0041]** Fig. 1 is a block diagram illustrating an example configuration of a main part of the pit monitoring device 4. The pit monitoring device 4 may be present inside the above-described control room 8 or elsewhere. As illustrated, the pit monitoring device 4 includes a control section 40, a storage section 41, a display section 42, and an operation section 43. The control section 40 centrally controls individual sections of the pit monitoring device 4. The storage section 41 stores various pieces of data for use by the pit monitoring device 4. The display section 42 presents various pieces of data stored in the storage section 41 to the user in such a manner that the user is able to see the data. The operation section 43 accepts an operation by the user on the pit monitoring device 4. The display section 42 may be integrated with or external to the pit monitoring device 4.

**[0042]** The pit monitoring device 4 further includes a communication section (not shown) for communicating with other devices (in the example illustrated in Fig. 1, the weighing device 11, the waste type registering device 12, the height measuring device 13, the crane PLC 14, and the incinerator monitoring device 7).

**[0043]** The control section 40 includes a data obtaining section 60, an event determining section 61, a deposition information generating section 62, an instructing section 63, and a display control section 64 each as a functional block. Each functional block of the control section 40 described above is achieved by, for instance, a central processing unit (CPU) loading onto a random access memory (RAM; not shown) a program stored in a storage device (storage section 41) that is in the form of, for example, a read-only memory (ROM) or a non-volatile random access memory (NVRAM). The storage section 41 stores bringing-in data 70, measurement data 71, crane data 72, event information 73, and deposition information 74.

**[0044]** The data obtaining section 60 obtains various pieces of data from other devices through the communication section (not shown), processes the data as necessary, and stores the data in the storage section 41. For instance, the data obtaining section 60 obtains various pieces of data from the devices included in the waste pre-acceptance measurement facility 1, imparts necessary association to the data to generate bringing-in data, and stores the bringing-in data in the storage section 41. More specifically, the data obtaining section 60 obtains waste weight data from the weighing device 11 and waste type data from the waste type registering device 12, and associates the waste weight data and the waste type data with each other to generate bringing-in data 70.

**[0045]** The data obtaining section 60 obtains from the height measuring device 13 measurement data produced as a result of measuring the respective heights of waste at different positions in the pit 21, and stores the obtained data in the storage section 41 as measurement data 71. The measurement data is information on the respective heights of waste at different coordinates on an X-Y plane in the pit 21.

**[0046]** The height measuring device 13 of the present embodiment carries out measurement preferably at intervals shorter than the intervals at which any of the following events occurs: bringing-in by a garbage truck Q and stirring and taking-out by the crane 5. For instance, in a case where any of the bringing-in, stirring and taking-out events occurs at three-minute intervals on average, the height measuring device 13 scans the upper surface of (waste in) the pit 21 at one-minute intervals to measure the respective heights of waste at different positions. The data obtaining section 60 thus obtains measurement data every minute, associates the measurement data with a measurement (obtaining) date and time expressed at least in minutes, and stores the measurement data in the storage section 41 as measurement data 71.

**[0047]** The above arrangement allows the pit monitoring device 4 to monitor almost in real time the state of the pit 21, in particular, the respective heights of waste at different positions inside the entire pit 21. This in turn allows the pit monitoring device 4 to, every time an event has occurred inside the pit 21, accurately determine what the event is.

**[0048]** The data obtaining section 60 obtains from the crane PLC 14 data on, for example, the path of movement of the crane 5 and the weight of waste grabbing by the bucket 53, and stores the data in the storage section 41 as crane data 72.

**[0049]** The event determining section 61 determines, on the basis of various pieces of data obtained by the data obtaining section 60 (namely, bringing-in data 70, measurement data 71, and crane data 72), what event has occurred inside the pit 21. The event determination is based on an algorithm described later in detail. The event determining section 61 generates event information 73 including the determination result, and stores the event information 73 in the storage section 41.

**[0050]** The deposition information generating section 62 generates deposition information 74 indicative of the latest state of the inside of the pit 21 on the basis of bringing-in data 70, measurement data 71, and event information 73, and stores the deposition information 74 in the storage section 41. Deposition information 74 indicates the state of how a waste heap inside the pit 21 has been stirred. For instance, deposition information 74 associates each space defined by X-Y-Z three-dimensional coordinates inside the pit 21 with information on attributes of a waste block present in that space. Examples of the attributes include the types of waste in the waste block, the composition of the respective propor-

tions of the waste types, and the degree or number of times of stirring of the waste. The user is able to learn, on the basis of the attribute information, the state of how the waste in the waste block has been stirred.

**[0051]** The attributes of a waste block may further include the degree of combustion of waste. The combustion degree is determined on the basis of, for example, the waste type or the composition of the respective proportions of the waste types. The combustion degree is, as an example, expressed as one of the following three stages: high, middle, and low. A waste block with a "high" combustion degree produces a large amount of heat (for example, a heat amount larger than expected) when combusted. A "middle" combustion degree indicates that a normal amount of heat is produced (for example, a minimally required heat amount). A "low" combustion degree indicates that a small amount of heat is produced (for example, a heat amount smaller than expected).

**[0052]** The deposition information generating section 62 may further be configured to, on the basis of at least the combustion degree among the combustion degree, the composition of the respective proportions of the waste types, the degree of stirring of the waste, and the like each set for each waste block, calculate the amount of heat (calories) predicted to be produced through incineration. The deposition information generating section 62 may then provide each waste block with information on the calculated calories. This arrangement allows the user to check deposition information 74 to control the pit monitoring device 4 and the crane PLC 14 in such a manner as to cause a waste block provided with information on high calories to be put into a hopper 22.

**[0053]** The three-dimensional coordinates may have any pitch. For instance, deposition information 74 may include the above-described types of information for each of the blocks into which the space inside the pit 21 is segmented and each of which has a size equivalent to the bucket (that is, in the shape of a square with sides measuring 1 to 2 m). Deposition information 74 may alternatively include the above-described types of information for each of the blocks into which the space inside the pit 21 is segmented and each of which is in the shape of a square with sides measuring several centimeters (smaller blocks).

**[0054]** The instructing section 63 instructs the crane PLC 14, while specifying detailed operations to be carried out by the crane 5, to control how the crane 5 is to be driven. Specifically, the instructing section 63 transmits, to the crane PLC 14, information on (i) a position at which the crane 5 is to carry out a grabbing operation (that is, coordinates on an X-Y plane) and (ii) a position at which the crane 5 is to carry out a dropping operation or putting-in operation (that is, coordinates on an X-Y plane) for stirring or taking-out instruction.

**[0055]** The instructing section 63 may transmit a stirring or taking-out instruction in response to an instruction entered by the user into the pit monitoring device 4 through the operation section 43 to drive the crane. The instructing section 63 may alternatively transmit the above instruction in response to a putting-in instruction from the incinerator monitoring device 7 or in a case where the instructing section 63 has determined on the basis of updated deposition information 74 that the instructing section 63 needs to transmit the above instruction. The instructing section 63 may further transmit, to the crane PLC 14 on the basis of the current height of a waste heap, information on a position (that is, a Z coordinate) to which the bucket 53 is to be lifted or lowered.

**[0056]** The display control section 64 generates an image that visualizes various pieces of data and information stored in the storage section 41, and causes the display section 42 to display the image. Specifically, the display control section 64 is capable of causing the display section 42 to display at least one of bringing-in data 70, measurement data 71, crane data 72, event information 73, and deposition information 74.

<Structure of various types of data>

(Bringing-in data)

**[0057]** Fig. 4 is a diagram illustrating a specific example of the data structure of bringing-in data 70. Bringing-in data 70 is structured to have, for example, the following items: bringing-in date and time, bringing-in entrance, bringing-in amount, and waste type. The data obtaining section 60 generates bringing-in data 70 each time a garbage truck Q brings in waste.

**[0058]** The item "bringing-in date and time" indicates information on the date and time when waste collected by a garbage truck Q was brought into the pit 21. The data obtaining section 60 may obtain, as bringing-in date and time, information on the date and time when a staffer entered data into an information processing device (for example, the waste type registering device 12) placed in the waste pre-acceptance measurement facility 1. The data obtaining section 60 may alternatively obtain, as bringing-in date and time, information on (i) the date and time when the weighing device 11 obtained, generated, or transmitted waste weight data or (ii) the date and time when the waste type registering device 12 obtained, generated, or transmitted waste type data. The data obtaining section 60 may alternatively receive, as bringing-in date and time from an information processing device (not shown) configured to control the opening and closing of each bring-in door 24, information on the date and time when a bring-in door 24 was opened and closed.

**[0059]** The item "bringing-in entrance" indicates information on which of the bring-in doors 24 illustrated in Fig. 3 was used to bring in waste. For instance, the above information processing device configured to control the opening and closing of each bring-in door 24 may transmit, to the pit monitoring device 4, information on the ID of the bring-in door 24 that was opened and closed (each bring-in door 24 has been assigned an ID). The data obtaining section 60 receives the information on the ID of

the bring-in door 24 as information indicative of the bringing-in entrance. Information on the bringing-in entrance (that is, the ID of a bring-in door 24) is used by the pit monitoring device 4 to estimate which area of the pit 21 illustrated in Fig. 3 waste was newly added in.

**[0060]** The item "bringing-in amount" indicates information on the amount of waste brought into the pit 21. For instance, the data obtaining section 60 receives waste weight data from the weighing device 11 as information on the bringing-in amount. The item "bringing-in amount" may alternatively indicate information on the volume of waste.

**[0061]** The item "waste type" indicates information on the type of waste brought into the pit 21. The data obtaining section 60 receives waste type data from the waste type registering device 12 as information on the waste type. For instance, the data obtaining section 60 stores, under "waste type", information indicative of a combustible waste or an incombustible waste.

(Measurement data)

**[0062]** (a) and (b) of Fig. 5 are each a diagram illustrating a specific example of the data structure of measurement data 71. Measurement data 71 is structured to associate each point defined by XY coordinates on an X-Y plane of the pit 21 with height information on the height of waste.

**[0063]** (a) of Fig. 5 illustrates an example of measurement data 71 provided by the height measuring device 13. The three-dimensional graph illustrated in the drawing is produced by (i) determining, on the basis of a distance measured by the height measuring device 13 through laser irradiation, the height of waste at each position defined by XY coordinates and (ii) plotting the value of the height as a Z coordinate.

**[0064]** In another embodiment, measurement data 71 may be converted, on the basis of the above-described three-dimensional graph, into a two-dimensional table illustrated in (b) of Fig. 5. (b) of Fig. 5 illustrates an example case in which the pit 21 is segmented into 16 $\times$ 5 (= 80) cells on an X-Y plane. Each cell is associated with a value (cm) indicative of the height of the waste in the area corresponding to the cell. Measurement data 71, which is formatted with a matrix of 5 $\times$ 16 (= 80) cells in the drawing as an example, may be formatted with a matrix of 100 $\times$ 320 cells or even more cells, depending on the scanning capacity (resolution) of the height measuring device 13.

**[0065]** Measurement data 71 may be presented on the display section 42 under control of the display control section 64. Measurement data 71 may be presented in the form of a three-dimensional graph as illustrated in (a) of Fig. 5 or in the form of a two-dimensional table as illustrated in (b) of Fig. 5.

**[0066]** The height measuring device 13 of the present embodiment scans the upper surface of (waste in) the pit 21 at one-minute intervals. Measurement data 71 is thus transmitted to the pit monitoring device 4 every minute. The data obtaining section 60, each time it receives measurement data 71, associates the measurement data 71 with information on the measurement date and time, and stores the measurement data 71 in the storage section 41.

(Crane data)

**[0067]** Fig. 6 is a diagram illustrating a specific example of the data structure of crane data 72. Crane data 72 is structured to have, for example, the following items: driving date and time, X coordinate, Y coordinate, and bucket weight. The data obtaining section 60 receives data on the above items from the crane PLC 14, and stores the data as crane data 72.

**[0068]** The item "driving date and time" indicates information on the date and time when the crane PLC 14 determined the corresponding X coordinate, Y coordinate, and bucket weight.

**[0069]** The item "X coordinate" indicates information on the position of the bucket 53 in the X direction of the waste acceptance facility 2, that is, the position of the girder 51.

**[0070]** The item "Y coordinate" indicates information on the position of the bucket 53 in the Y direction of the waste acceptance facility 2, that is, the position of the transverse carriage 52.

**[0071]** The item "bucket weight" indicates information on the weight of waste grabbed by the bucket 53.

**[0072]** With crane data 72 stored, plotting the position of the bucket 53 as XY coordinates for each driving date and time allows the path of movement of the crane 5 (bucket 53) to be drawn. Further, a change in the weight of waste inside the bucket 53 can indicate when and where the crane 5 grabbed waste and how much the crane 5 grabbed (or released).

**[0073]** The crane PLC 14 measures and monitors the position (that is, the XY coordinates) of the bucket 53 and the bucket weight every several seconds or several minutes. The crane PLC 14 may transmit, to the pit monitoring device 4, a piece of crane data 72 each time the crane PLC 14 has carried out measurement (that is, every several seconds or several minutes) or a plurality of pieces of crane data 72 together every several tens of minutes or several hours.

(Event information)

**[0074]** (a) and (b) of Fig. 7 are each a diagram illustrating a specific example of the data structure of event information 73. Event information 73 is structured to have, for example, the following items: occurrence date and time, determination result, increase area, increase amount, decrease area, and decrease amount as illustrated in (a) of Fig. 7. The event determining section 61, each time new measurement data 71 is stored in the storage section 41, compares the new measurement da-

ta 71 with the immediately previously stored measurement data 71 for an event determining process. In a case where the event determining section 61 has determined as a result of the event determining process that some event (or part of the event) has occurred, the event determining section 61 generates event information 73 about the event the occurrence of which the event determining section 61 has determined.

**[0075]** Events are classified into (i) short-term events (which occur over a short period of time such as approximately one minute), (ii) mid-term events (which occur over a period of time of several minutes), and (iii) long-term events (which occur gradually over several tens of minutes to several hours or longer). For instance, "bringing-in" and "heap slide" are short-term events. The event determining section 61 is usually capable of determining such events through a single event determining process based on a single comparison. "Stirring" and "taking-out" are mid-term events. The event determining section 61 is capable of determining such events through a plurality of event determining processes based on a plurality of (for example, two) comparisons. For instance, in a case where the event determining section 61 determined "grabbing" as a crane operation at a time point and determined "dropping" several minutes later, the event determining section 61 can determine on the basis of the two determinations that "stirring" has occurred. The event determining section 61 may determine "grabbing" as a crane operation at a time point and determine "grabbing" again several minutes later without determining "dropping" subsequent to the first "grabbing" operation. In this case, the event determining section 61 determines that the previous "grabbing" operation is part of "taking-out" and that "taking-out" has occurred. The event determining section 61 may also refer to crane data 72 to determine, even before determining the second "grabbing" operation, that "taking-out" has occurred. Long-term events will be described later in detail. The event determining section 61 is capable of (i) tracking, on the basis of a large number of pieces of measurement data 71, how the height of waste changes over time and thereby (ii) determining an event (for example, "sinking" due to the self weight of the waste).

**[0076]** The event determining section 61 generates a piece of event information 73 for each event (or crane operation) determined through a single event determining process based on a single comparison. Thus, in a case where a "heap slide" and a "grabbing" crane operation have occurred substantially simultaneously, the event determining section 61 generates a total of two pieces of event information 73: one for the "heap slide" and the other for the "grabbing" operation.

**[0077]** The item "occurrence date and time" indicates information on the date and time when an event determined by the event determining section 61 occurred. The event determining section 61 may use, as the occurrence date and time, the measurement date and time for the immediately previous measurement data 71 (first measurement date and time). The event determining section 61 may alternatively use, as the occurrence date and time, (i) the measurement date and time for the latest measurement data 71 (second measurement date and time), (ii) an intermediate time point between the first measurement date and time and the second measurement date and time, or (iii) the period from the first measurement date and time to the second measurement date and time.

**[0078]** The item "determination result" indicates information on the result of an event determining process carried out by the event determining section 61. This item has the sub-items "event" and "crane operation" as an example. "Event" indicates information on an event determined, and indicates an event such as "heap slide", "bringing-in", "stirring", or "taking-out". "Crane operation" indicates information on an operation by the crane 5 which operation is defined through a single event determining process, and indicates a crane operation such as "grabbing" or "dropping". "Putting-in" is an operation of putting waste into a hopper 22, and does not change the height of waste in the pit 21. The event determining section 61 thus does not determine "putting-in" on the basis of only a comparison between different pieces of measurement data 71.

**[0079]** The item "increase area" indicates information on an area in the pit 21 in which area the height of waste has increased. The event determining section 61 compares the latest measurement data 71 with the immediately previous measurement data 71 to determine an increase area. The event determining section 61 may determine a plurality of increase areas inside the pit 21 on the basis of a single comparison. An increase area is indicated by any format of data on a group of XY coordinates.

**[0080]** The item "increase amount" indicates information on the weight of waste having increased in an increase area described above. The event determining section 61 may determine an increase amount on the basis of (i) "bringing-in amount" described above, (ii) "bucket weight" described above, or (iii) deposition information 74 for a portion of a waste heap at which portion a heap slide occurred, the deposition information 74 being stored before the heap slide.

**[0081]** In a case where a crane operation that the event determining section 61 has determined is "grabbing", the event determining section 61 may leave the items "increase area" and "increase amount" blank (null) for event information 73 about the "grabbing" operation.

**[0082]** The item "decrease area" indicates information on an area in the pit 21 in which area the height of waste has decreased. The event determining section 61 compares the latest measurement data 71 with the immediately previous measurement data 71 to determine one or more decrease areas. A decrease area is indicated by any format of data on a group of XY coordinates.

**[0083]** The item "decrease amount" indicates information on the weight of waste having decreased in a de-

crease area described above. The event determining section 61 may determine a decrease amount on the basis of (i) "bucket weight" described above or (ii) deposition information 74 for a portion of a waste heap at which portion a heap slide occurred, the deposition information 74 being stored before the heap slide.

**[0084]** The description below deals with a specific example with reference to (b) of Fig. 7. In a case where the event determining section 61 has defined an event through a single determination as described above, the event determining section 61 categorizes the thus-determined short-term event as an "event" (sub-item). For instance, the event determining section 61 generates event information 73 indicating that "bringing-in" occurred at "2017/5/15 11:56". The event determining section 61 also inputs respective values under "increase area" and "increase amount" (not detailed) in the event information 73 about the "bringing-in" event. A "bringing-in" event does not involve a crane operation. The event determining section 61 may thus leave the item "crane operation" blank (null) for the event information 73 about the "bringing-in" event.

**[0085]** In a case where the event determining section 61 defines a mid-term event through two determinations, the event determining section 61 first categorizes a crane operation defined through a first determination as a "crane operation" (sub-item) for a first piece of event information 73. For instance, the event determining section 61 generates event information 73 indicating that "grabbing" occurred at "2017/5/15 12:00". The event determining section 61 also inputs respective values under "decrease area" and "decrease amount" in the event information 73 for the "grabbing" event.

**[0086]** Next, the event determining section 61 categorizes a crane operation defined through a second determination as a "crane operation" (sub-item) for a second piece of event information 73. For instance, the event determining section 61 generates event information 73 indicating that "dropping" occurred at "2017/5/15 12:02". The event determining section 61 also inputs respective values under "increase area" and "increase amount" in the event information 73 about the "dropping" event.

**[0087]** In a case where the event determining section 61 has determined that "dropping" has occurred after "grabbing", the event determining section 61 pairs the two pieces of information with each other to determine that a single "stirring" event has occurred. Specifically, the event determining section 61 pairs the event information 73 for "grabbing" with the event information 73 for subsequent "dropping" and categorizes, as an "event" (sub-item) and in association with the pair of pieces of event information 73, the determination result indicating that "stirring" has occurred.

**[0088]** As another example, the event determining section 61 generates event information 73 indicating that "grabbing" occurred at "2017/5/ 15 12:03" about a crane operation defined through a first determination. The event determining section 61 then generates event information 73 indicating that "grabbing" occurred at "2017/5/15 12:08" about a crane operation defined through a second determination subsequent to the first determination.

**[0089]** In a case where the event determining section 61 has determined that "grabbing" has occurred after the immediately previous "grabbing" operation without occurrence of "dropping", the event determining section 61 determines on the basis of the immediately previous "grabbing" operation that occurred at "12:03" that a single "taking-out" event has occurred. Specifically, the event determining section 61 categorizes, as an "event" (sub-item) and in association with the event information 73 for the immediately previous "grabbing" operation, the determination result indicating that "taking-out" has occurred.

**[0090]** It is indeterminable at this time point whether the newly determined "grabbing" operation that occurred at " 12:08" is part of a "stirring" event or "taking-out" event. The event determining section 61 thus leaves the sub-item "event" blank in the event information 73 about the new "grabbing" operation at the time when the "grabbing" operation was determined. The event determining section 61 will determine the current event on the basis of a crane operation to be determined next or later.

**[0091]** The event determining section 61 is capable of determining, before determining "grabbing" that occurred at "12:08," that "grabbing" that occurred at "12:03" is part of "taking-out". For instance, the event determining section 61 refers to crane data 72 for the period of 12:03 to 12:08. In a case where during the period, (i) the bucket 53 is placed at such a position (that is, XY coordinates) as to coincide with a hopper 22 and (ii) the bucket weight is decreased by a value equivalent to the waste grabbed, the event determining section 61 is capable of determining, on the basis of "grabbing" that occurred at "12:03" that a single "taking-out" event has occurred.

(Deposition information)

**[0092]** Figs. 8 and 9 are each a diagram illustrating a specific example of the data structure of deposition information 74. Deposition information 74 is structured such that each position (that is, XYZ coordinates) in a three-dimensional space of the pit 21 is associated with information on attributes of a waste block present at that position.

**[0093]** For instance, deposition information 74 is structured such that each position defined by XY coordinates on an X-Y plane of the pit 21 is associated with a single bar extending in the Z direction as illustrated in Fig. 8. Each bar has (i) a lower end in the Z direction which lower end corresponds to the bottom surface of the pit 21 and (ii) an upper end in the Z direction which upper end corresponds to the highest point of the waste at the position. In other words, each bar has a dimension in the Z direction which dimension corresponds to the height of waste at the position.

**[0094]** Each bar has Z coordinates each associated with information on an attribute (specifically, the degree of stirring) of the waste block present at that position (height). The degree of stirring is information on how much the waste has been stirred by the crane 5. A higher degree of stirring indicates a higher homogeneity of waste (that is, a higher uniformity in terms of composition of the respective proportions of different waste types).

**[0095]** The degree of stirring is expressed in percentage, with 0% indicating that the number of times of stirring is 0 and 100% indicating an ideal number of times of stirring which ideal number is based on, for example, knowledge acquired from an experience. A larger percentage value indicates that the waste has been stirred to a higher degree. The deposition information generating section 62 is capable of determining the degree of stirring of a waste block on the basis of the number of times of stirring which number has been counted by the event determining section 61 on the basis of event information 73. As another example, the degree of stirring may be expressed in levels, with level 1 indicating that the number of times of stirring is 0 and level 5 indicating an ideal number of times of stirring. A higher level indicates that the waste has been stirred to a higher degree.

**[0096]** Each bar has a portion(s) along the height of the waste block which portion(s) is provided with a value indicative of the degree of stirring of the waste block. Different portions are preferably displayed differently in a visual sense according to the degree of stirring. For instance, different portions preferably have respective colors different from each other according to the degree of stirring.

**[0097]** Fig. 8 shows a bar 741 at a position defined by an X coordinate on the fourth column (X4 column) and a Y coordinate on the first row (Ya row). The bar 741 indicates that at this position, the waste block present in a space extending from the lower end to a height of one third has a stirring degree of level 1 and the remaining waste block (two thirds) has a stirring degree of level 2.

**[0098]** The deposition information generating section 62 may (i) determine a degree of stirring of waste between two bars adjacent to each other in the X or Y direction or in an oblique direction and (ii) associate the waste with the degree of stirring. The deposition information generating section 62 determines that the degree of stirring of the upper end (that is, the waste block present at the top at the position) of that one of two adjacent bars which bar has smaller XY coordinate values is the degree of stirring associated with the pair of bars. In the example illustrated in Fig. 8, the deposition information generating section 62 determines, on the basis of the fact that the degree of stirring of the upper end of the bar 741 (which has smaller coordinate values) is level 2, that waste between the bar 741 and a bar 742 adjacent to the bar 741 in the X direction and having a larger X-coordinate value has a degree of stirring of level 2. The pit monitoring device 4 then preferably connects the respective upper ends of the adjacent bars with a line and displays the line in a color corresponding to the degree of stirring associated with the bar pair. This arrangement allows the user to intuitively understand the degree of stirring of the surface of the entire waste heap inside the pit 21.

**[0099]** The deposition information generating section 62 may (i) determine a degree of stirring of a set of three bars adjacent to each other in the X or Y direction or in an oblique direction and (ii) associate the set with the degree of stirring. For instance, the deposition information generating section 62 may determine a degree of stirring of a bar set on the basis of the degree of stirring of the upper end of one of the three bars. The pit monitoring device 4 then preferably draws a right triangle with the vertexes at the respective upper ends of the three bars, paints the right triangle in a color corresponding to the degree of stirring associated with the bar set, and displays the right triangle. This arrangement allows the user to more intuitively understand the degree of stirring of the surface of the entire waste heap inside the pit 21.

**[0100]** Deposition information 74 may be displayed on the display section 42 in a two-dimensional form. Fig. 9 is a diagram illustrating deposition information 74 about a plane on the first row as a Y coordinate (Ya row). For instance, when the three-dimensional deposition information 74 illustrated in Fig. 8 is displayed on the display section 42, the user selects the Ya row and enters, into the pit monitoring device 4 with use of the operation section 43, an instruction to display two-dimensional deposition information 74. The deposition information generating section 62, in response, reads out only deposition information 74 on the Ya row and causes the display section 42 to display the two-dimensional deposition information 74 illustrated in Fig. 9. This arrangement allows the user to see a cross section of the waste heap inside the pit 21 and thereby easily understand the degree of stirring of not only the surface but also a lower layer of the waste block. The example illustrated in the drawing will allow the user to understand at a glance that an upper-layer portion of the waste heap has been stirred relatively well, whereas a lower-layer portion thereof has been hardly stirred.

**[0101]** Figs. 8 and 9 each illustrate deposition information 74 with a large coordinate pitch for a three-dimensional space for the purpose of easy view and simplified description. The coordinate pitch of deposition information 74 may, however, be smaller unlike in the example illustrated in Figs. 8 and 9. Such a smaller coordinate pitch, which may increase the processing load on the deposition information generating section 62, allows the user to accurately understand the state of a waste heap inside the pit 21 in greater detail.

**[0102]** The deposition information generating section 62, each time the event determining section 61 generates event information 73, updates deposition information 74 in accordance with the newly generated event information 73. Specifically, the deposition information generating section 62 updates deposition information 74 by, for

example, changing the height of a bar for an area in which the height of waste has been changed and/or recalculating the degree of stirring associated with a bar, a bar pair, or a bar set.

<Process flow>

(Event determining process)

**[0103]** Fig. 10 is a flowchart illustrating the flow of an event determining process that the event determining section 61 carries out. In a case where the data obtaining section 60 has obtained new measurement data 71 and stored the measurement data 71 into the storage section 41 (YES in S101), the event determining section 61 starts an event determining process.

**[0104]** The event determining section 61 reads out the newly stored, latest measurement data 71 and immediately previously stored measurement data 71 from the storage section 41 (S102). The event determining section 61 compares the two pieces of measurement data 71. In a case where there is one or more height change areas in each of which the height of waste has increased or decreased by not less than a predetermined value (YES in S103), the event determining section 61 will determine in detail what event has occurred in each height change area.

**[0105]** For instance, first, in a case where there is one or more decrease areas in each of which the height of waste has decreased by not less than a predetermined value (YES in S104), the event determining section 61 proceeds with one such decrease area as a target (S105). For instance, in a case where the measurement data 71 illustrated in (a) of Fig. 5 is the immediately previous measurement data 71, and the measurement data 71 illustrated in Fig. 12 is the current measurement data 71, a comparison between the two pieces of measurement data 71 shows that the area indicated with a broken line in Fig. 12 is a decrease area in which the height of waste has decreased by not less than a predetermined value. The event determining section 61 will determine what event has caused the height of waste to decrease in the target decrease area indicated with the broken line.

**[0106]** The event determining section 61 reads out crane data 72 from the storage section 41. The event determining section 61 then determines whether the crane data 72 has a history of operation of the crane 5 in the target decrease area and a place near the decrease area within the time frame extending from a first measurement date and time for the immediately previous measurement data 71 to a second measurement date and time for the current measurement data 71 (S106). In a case where the crane data 72 has a history of operation of the crane 5 in the target decrease area and a place near the decrease area within the above time frame (YES in S106), the event determining section 61 determines that the decrease in the height of waste in the decrease area was caused by a "grabbing" operation by the crane 5 (S107).

**[0107]** Subsequently, the event determining section 61 determines whether the storage section 41 stores a record of a past "grabbing" operation entered before the entry of the result of determination of the current "grabbing" crane operation which past "grabbing" operation has not been paired with a "dropping" crane operation, that is, has not been determined as to whether the past "grabbing" operation is part of "stirring" or "taking-out" (S108). In a case where the storage section 41 stores a record of a past "grabbing" operation that has not been determined as to whether the past "grabbing" operation is part of "stirring" or "taking-out" (YES in S108), the event determining section 61 determines on the basis of the result of determination of the past "grabbing" operation that "taking-out" has been carried out (S109). The event determining section 61 has thus determined that the crane 5 carried out two consecutive "grabbing" operations (with no determination of "dropping" therebetween). This is based on the following assumption: The crane 5 released the grabbed waste at such a place as not to change the height of the waste heap, that is, put the waste into a hopper 22, between the above two "grabbing" operations.

**[0108]** In a case where the storage section 41 stores no record of a past "grabbing" operation that has not been determined as to whether the past "grabbing" operation is part of "stirring" or "taking-out" (NO in S108), the event determining section 61 may at this stage postpone determining whether the current "grabbing" operation is part of "stirring" or "taking-out" (S110). When the event determining section 61 can refer to a history of operation of the crane 5 within a time frame subsequent to the time frame within which the current "grabbing" operation occurred, the event determining section 61 will determine, on the basis of the operation history, that the current "grabbing" operation is an operation carried out by the crane 5 as part of "taking-out". Specifically, the event determining section 61 refers to crane data 72 (see Fig. 6) for a time frame subsequent to the time frame within which the current "grabbing" operation occurred. In a case where the XY coordinates indicative of the position of the crane 5 are identical to those indicative of the position (X, Y) of a hopper 22 or are within a predetermined distance from the position (X, Y) of a hopper 22, the event determining section 61 determines that the waste was put into the hopper 22 after the current "grabbing" operation. The event determining section 61, as a result, determines on the basis of the current "grabbing" operation and "putting-in" that "taking-out" has been carried out.

**[0109]** In a case where there is no decrease area in S104, S105 to S108 are not carried out.

**[0110]** In a case where the crane data 72 has no history of operation of the crane 5 in the target decrease area and a place near the decrease area within the above time frame (NO in S106), the event determining section 61 proceeds further with, as a target, one or more increase areas determined in S 103, and will check an increase

area (S 111). A decrease in the height of the waste heap which decrease has been caused in no relation to operation of the crane 5 is probably due to a heap slide. The event determining section 61 will carry out the checking operation below to definitively determine that a "heap slide" has occurred.

**[0111]** The event determining section 61 determines whether the target increase area is present around the decrease area targeted in S105 (S112). In a case where the increase area is present in such a pattern as to surround the decrease area (YES in S112), the event determining section 61 determines that the decrease in the height of waste in the decrease area and the increase in the height of waste in the increase area are due to the same "heap slide" (S113).

**[0112]** In a case where the increase area as a target does not meet the condition of S112 about the positional relationship with the decrease area, or there is no decrease area in S104 (NO in S112), the event determining section 61 determines that the waste increase in the increase area is not due to a heap slide, and proceeds with another checking operation. A waste increase is, if it is not due to a heap slide, probably due to "bringing-in" or "dropping". The event determining section 61 proceeds with the checking operation below to determine whether the waste increase is due to "bringing-in" or "dropping".

**[0113]** The event determining section 61 reads out bringing-in data 70 from the storage section 41. The event determining section 61 then determines whether (i) the increase area as a target belongs to the acceptance area of the pit 21 and (ii) the bringing-in data 70 has a history of waste having been brought in from a bring-in door 24 closest to the increase area within the time frame extending from the first measurement date and time to the second measurement date and time (S114). In a case of YES in S114, the event determining section 61 determines that the increase in the height of waste in the increase area is due to "bringing-in" (S115). In a case of NO in S114, the event determining section 61 determines that the increase is due to "dropping" (S116). The storage section 41 stores a record of the result of determination of "grabbing" which record was entered before the entry of the result of determination of the current "dropping" operation. This record of the result of determination is of a "grabbing" operation that has not been determined as to whether the "grabbing" operation is part of "stirring" or "taking-out". The event determining section 61 thus pairs the result of determination of the immediately previous "grabbing" operation with the result of determination of the current "dropping" operation, and determines on the basis of these determination results that "stirring" has been carried out (S117).

**[0114]** The event determining section 61 generates event information 73 associated with the determination result obtained in S107, S113, S115, or S116 about the target decrease area or increase area as a target, and stores the event information 73 in the storage section 41 (S118). The event determining section 61, on the basis of the determination result obtained in S109, also updates the event information 73 already stored in the storage section 41.

**[0115]** In a case where there are a plurality of decrease areas or increase areas in S103, the event determining section 61 returns from S118 to S104, and repeats S104 to S118 about another decrease area or increase area as a target. This arrangement allows the pit monitoring device 4 to, even in a case where a plurality of events have occurred substantially simultaneously, determine each of the events and record each determination result as event information 73.

**[0116]** In a case where a change in the height of waste by not less than a predetermined value is not found anywhere inside the pit 21 (NO in S103), the event determining section 61 determines that no event has occurred (S119), and may end the process without generating event information 73. The event determining section 61 then transitions into a state where the event determining section 61 waits for subsequent measurement data 71.

(Deposition information generating process)

**[0117]** Fig. 11 is a flowchart illustrating the flow of a deposition information generating process that the deposition information generating section 62 carries out. In a case where the event determining section 61 has generated new event information 73 and stored the event information 73 into the storage section 41 (YES in S201), the deposition information generating section 62 starts a deposition information generating process.

**[0118]** In deposition information 74 of the present embodiment, a waste block is expressed as a corresponding bar. In the description below of the flowchart, an expression of the deposition information generating section 62 processing a waste block (for example, moving, removing, or adding a waste block) specifically means the deposition information generating section 62 processing a portion of the bar corresponding to the waste block.

**[0119]** In a case where the event information 73 indicates a "heap slide" as a "determination result" (YES in S202), the deposition information generating section 62 updates the deposition information 74. Specifically, the deposition information generating section 62 moves a waste block at an upper portion in a decrease area to an upper portion in an increase area (S203). The deposition information generating section 62 is capable of determining a decrease area and increase area on the basis of the coordinates indicated by the event information 73. The deposition information generating section 62 reads out measurement data 71 indicating a measurement date and time identical (or close) to the occurrence date and time indicated by the event information 73, and thereby determines the height of waste in each area after the movement. The deposition information generating section 62 is also capable of determining, on the basis of information on the increase amount and decrease amount which information is included in the event infor-

mation 73, the number of waste blocks to be moved. The deposition information generating section 62 also updates, on the basis of (i) the attribute information of the waste block having been moved which attribute information was information before the movement and (ii) the attribute information of a waste block in the area to which the above waste block was moved, the attribute information of a waste block resulting from the movement. For instance, the deposition information generating section 62 updates information on the waste types and/or composition of the respective proportions of the waste types (S204). A "heap slide" may contribute to homogenizing waste by moving waste similarly to "stirring" by the crane 5. The deposition information generating section 62 may update information on the number of times of stirring, degree of stirring, degree of combustion, and calories of a waste block moved on the basis of a "heap slide". This arrangement allows (i) a heap slide (that is, a mass of waste in a waste heap falling down from a high position to a lower area) to be determined and (ii) deposition information 74 to accurately represent the current state of the waste.

**[0120]** In a case where the event information 73 indicates "bringing-in" as a "determination result" (YES in S205), the deposition information generating section 62 adds a new waste block at an upper portion in the increase area (S206). The deposition information generating section 62 determines the number of waste blocks for the addition on the basis of (i) the increase amount indicated by the event information 73 or (ii) bringing-in data 70 indicating a bringing-in date and time near the occurrence date and time indicated by the event information 73. The deposition information generating section 62 determines the attribute information of the waste block for the addition (that is, the waste types, composition of the respective proportions of the waste types, degree of combustion, and calories) on the basis of bringing-in data 70. The deposition information generating section 62 naturally sets each of the degree of stirring and number of times of stirring to an initial value (for example, 0% or 0 times) because the waste has just been brought in. This arrangement allows (i) an event of waste having been brought into the pit 21 from a bring-in door 24 to be determined and (ii) deposition information 74 to accurately represent the current state of the waste.

**[0121]** In a case where the event information 73 indicates "grabbing" as a "determination result" (YES in S207), the deposition information generating section 62 determines whether the event determining section 61 has determined that "grabbing" as a "determination result" indicated by event information 73 generated before the current event information 73 is part of "taking-out" (S208). In a case where the event determining section 61 has not determined as such (NO in S208), the deposition information generating section 62 proceeds to S209 because the deposition information generating section 62 does not need to update the deposition information 74 on the basis of previous event information 73. Specifically, the deposition information generating section 62 removes a waste block at an upper portion in the decrease area that is based on the current event information 73, and saves the removed waste block and the attribute information thereof in a cache (S209). This is because it is indeterminable at this time point whether the current "grabbing" operation is part of "stirring" or "taking-out" and thus where the removed waste block is to be moved to.

**[0122]** In a case where the event determining section 61 has determined as above (YES in S208), the deposition information generating section 62 does not return, into the pit 21, the waste block saved on the basis of the previous "grabbing" operation, and deletes the waste block from the cache (S210). This arrangement allows (i) an event of grabbed waste having been put into a hopper 22 to be determined and (ii) deposition information 74 to accurately represent the current state of the waste.

**[0123]** In a case where the event information 73 indicates "dropping" as a "determination result" (YES in S211), the deposition information generating section 62 moves, to the increase area, a waste block that the deposition information generating section 62 saved in a cache on the basis of previous event information 73 indicating "grabbing" as a "determination result" (S212).

**[0124]** A "dropping" operating by the crane 5 may last longer than a time interval (for example, one minute) at which the height measuring device 13 scans the upper surface of (waste in) the pit 21 to measure the height of waste. In other words, after a single "grabbing" operation is determined (S107 in Fig. 10), a plurality of "dropping" operations may be determined consecutively (5116 in Fig. 10). In view of that, the deposition information generating section 62, even after the deposition information generating section 62 moves the waste block to the increase area in S212, preferably keeps the waste block saved in the cache. The deposition information generating section 62 may delete the above-kept waste block from the cache when the event determining section 61 determines a subsequent "grabbing" operation. This is because a subsequent "grabbing" operation should indicate that the above "dropping" operation has already been finished.

**[0125]** The deposition information generating section 62 also updates, on the basis of (i) the attribute information of the waste block having been moved which attribute information was information before the movement and (ii) the attribute information of a waste block in the area to which the above waste block was moved, the attribute information of a waste block resulting from the movement (S213). For instance, the deposition information generating section 62 updates information on the waste types and/or composition of the respective proportions of the waste types. The current determination result of "dropping" means a single "stirring" event has been carried out. The deposition information generating section 62 thus updates information on the degree of stirring and/or

number of times of stirring of the waste block resulting from the movement. This arrangement allows (i) an event of grabbed waste having been dropped onto a different place inside the pit 21 to be determined and (ii) deposition information 74 to accurately represent the current state of the waste.

[Modification example]

**[0126]** The event determining section 61 may determine, as a long-term event, "sinking" of waste due to its self weight. The event determining section 61 may carry out not only a comparison and event determining process each time measurement data 71 is generated, but also an event determining process for determination of a long-term event when measurement data 71 for a long term (for example, one hour) has been stored into the storage section 41 a plurality of times.

**[0127]** For instance, even in a case where a comparison between different pieces of measurement data 71 every minute does not indicate a decrease in the height of waste by not less than a predetermined value, a comparison between a piece of measurement data 71 and another piece of measurement data 71 generated one hour later may indicate a decrease in the height of waste by not less than a predetermined value. In such a case, if no short-term or mid-term event did not occur during the one-hour period, the event determining section 61 is capable of determining that "sinking" occurred during the one-hour period.

**[0128]** The deposition information generating section 62 updates deposition information 74 about the area in which sinking occurred as the event determining section 61 has determined. Specifically, the deposition information generating section 62 compresses the entire bar for the area so that the height of the bar is reduced on the basis of the height of waste indicated by the measurement data 71. This arrangement allows deposition information 74 to accurately represent an event of sinking of waste due to its self weight.

**[0129]** The waste acceptance facility 2 of the waste incineration plant 100 may include a plurality of cranes 5. In this case, the event determining section 61 may determine a "grabbing" operation, a "dropping" operation for "stirring", and a "putting-in" operation for "taking-out" for each crane 5. The deposition information generating section 62 may cache, for each crane 5, information on a waste block and attribute information thereof for generating deposition information 74. This arrangement makes it possible to analyze, for example, the rate of operation of each crane 5, and allows the analysis result to be used to control the operation of each crane 5 efficiently.

**[0130]** The deposition information generating section 62 is configured to, on the basis of the result of determination of "taking-out", delete information on the waste block taken out of the pit 21, that is, the waste block put into a hopper 22, and attribute information of the waste block from the cache (S210 in Fig. 11). The present embodiment is, however, not limited to such an arrangement. The deposition information generating section 62 may be configured to delete information on the waste block put into a hopper 22 and attribute information of the waste block from the cache and store the information on the waste block and attribute information into the storage section 41 in a nonvolatile manner as taking-out data. Taking-out data is structured to have, for example, the following items: putting-in date and time, putting-in destination, putting-in amount, and attribute information. "Putting-in date and time" indicates information on the date and time when a waste block was put into a hopper 22. "Putting-in destination" indicates information on which hopper 22 the waste block was put into. "Putting-in amount" indicates information on the amount (that is, weight or volume) of the waste block put in. "Attribute information" is information set for the waste block. Example attributes indicated by attribute information include, as described above, the types of waste in the waste block, the composition of the respective proportions of the waste types, the degree of stirring of the waste block, the number of times of stirring of the waste block, the degree of combustion of the waste block, and the calories of the waste block.

**[0131]** The above arrangement allows the storage section 41 to store data on waste put into a hopper 22, and thereby makes it possible to learn how combustion at the waste incinerators 3 and waste put in correlate to each other. Analyzing the correlation makes it possible to determine what types of waste a waste block to be put in should contain (or what proportion composition the waste block should have) and when the waste block should be put in. This in turn makes it possible to control the waste incineration plant 100 on the basis of taking-out data for stable combustion.

**[0132]** The height measuring device 13 may be, other than a three-dimensional scanner including a laser sensor mounted therein, (i) a device for measuring the height on the basis of parallax of a plurality of cameras or (ii) a device for measuring the height with use of a stereo camera.

[Example of Configuration Achieved by Software]

**[0133]** Control blocks of the pit monitoring device 4 (particularly, the data obtaining section 60, the event determining section 61, the deposition information generating section 62, the instructing section 63, and the display control section 64) can be realized by a logic circuit (hardware) provided in an integrated circuit (IC chip) or the like or can be alternatively realized by software as executed by a central processing unit (CPU).

**[0134]** In the latter case, the pit monitoring device 4 includes a CPU that executes instructions of a program that is software realizing the foregoing functions; a read-only memory (ROM) or a storage device (each referred to as "storage medium") in which the program and various

kinds of data are stored so as to be readable by a computer (or a CPU); and a random access memory (RAM) that develops the program in executable form. An object of the present invention can be achieved by a computer (or a CPU) reading and executing the program stored in the storage medium. Examples of the storage medium encompass "a non-transitory tangible medium" such as a tape, a disk, a card, a semiconductor memory, and a programmable logic circuit. The program can be supplied to the computer via any transmission medium (such as a communication network or a broadcast wave) which allows the program to be transmitted. Note that an aspect of the present invention can also be achieved in the form of a computer data signal in which the program is embodied via electronic transmission and which is embedded in a carrier wave.

**[0135]** The present invention is not limited to the embodiments, but can be altered by a skilled person in the art within the scope of the claims. The present invention also encompasses, in its technical scope, any embodiment derived by combining technical means disclosed in differing embodiments.

**[0136]** The information processing device described above can be realized by a computer. The computer is operated based on (i) an information processing program for causing the computer to realize the information processing device by causing the computer to operate as each section (software element) included in the information processing device and (ii) a computer-readable storage medium in which the information processing program is stored.

Reference Signs List

**[0137]**

4 Pit monitoring device (information processing device)
5 Crane
11 Weighing device
12 Waste type registering device
13 Height measuring device (three-dimensional measurement device)
14 Crane PLC
21 Pit
22 Hopper
24 Bring-in door
60 Data obtaining section
61 Event determining section
62 Deposition information generating section
63 Instructing section
64 Display control section
70 Bringing-in data
71 Measurement data (first measurement data, second measurement data, third measurement data, three-dimensional measurement data)
72 Crane data
73 Event information
74 Deposition information

## Claims

**1.** An information processing device (4) for monitoring waste deposited inside a pit (21), the information processing device (4) comprising:

a data obtaining section (60) configured to obtain a plurality of pieces of measurement data (71) that is generated by a height measuring device (13) each time the height measuring device (13) carries out measurement and that indicates a height of the waste,
wherein the height measuring device (13) is a three-dimensional measurement device for measuring a surface shape of the waste deposited inside the pit (21),
the information processing device (4) further comprises:

an event determining section (61) configured to

compare (i) first measurement data generated as a result of previous measurement with (ii) second measurement data generated as a result of later measurement, both the first measurement data and the second measurement data being in a form of three-dimensional measurement data indicative of a shape of the waste,
determine one or more sets of XY-coordinate values as one or more respective height change areas in the pit (21) at each of which one or more sets the height of the waste which height is indicated with a Z-coordinate value has been changed by not less than a predetermined value,
determine an event related to movement of the waste that occurred in each of the one or more determined height change areas; and

a deposition information generating section (62) configured to, on a basis of the event determined, generate deposition information (74) indicative of a state of how the waste deposited inside the pit (21) has been stirred.

**2.** The information processing device according to claim 1, wherein

the data obtaining section (60) is configured to

obtain the plurality of pieces of measurement data (71) at an interval shorter than an interval at which the event occurs inside the pit (21),
the event determining section (61) is configured to, each time the data obtaining section (60) obtains a piece of the measurement data, determine the event by comparing (i) the second measurement data, which was obtained latest, with (ii) the first measurement data, which was obtained second latest, and
the deposition information generating section (62) is configured to update the deposition information each time the event determining section (61) determines the event.

**3.** The information processing device according to claim 1, wherein

the data obtaining section (60) is configured to obtain (i) crane data (72) indicative of a history of operation of a crane carrying the waste inside the pit (21) and (ii) bringing-in data (70) indicative of a history of waste being brought into the pit (21), and
the event determining section (61) is configured to, in a case where

(i) a decrease area in which the height of the waste was decreased and an increase area around the decrease area in which increase area the height of the waste was increased have been determined among the one or more height change areas,
(ii) the crane data (72) does not have a history of operation of the crane in the one or more height change areas within a first measurement time frame that extends from a first measurement date and time at which the first measurement data was generated to a second measurement date and time at which the second measurement data was generated, and
(iii) the bringing-in data (70) does not have a history of waste being brought into the one or more height change areas within the first measurement time frame,

determine that a heap slide occurred in the one or more height change areas within the first measurement time frame, the heap slide being an event of waste moving from a high position to a low position without artificial intervention.

**4.** The information processing device according to claim 1, wherein

the event determining section (61) is configured to,

in a case where the decrease area has been determined through comparison between the first measurement data and the second measurement data, and the crane data (72) has a history of operation of the crane in the decrease area within the first measurement time frame, determine a first crane operation of the crane grabbing waste in the decrease area,
in a case where the increase area has been determined through comparison between the second measurement data and third measurement data generated after the second measurement data, and the crane data (72) has a history of operation of the crane in the increase area within a second measurement time frame that extends from the second measurement date and time to a third measurement date and time at which the third measurement data was generated, determine a second crane operation of the crane dropping the grabbed waste in the increase area, and
determine on a basis of the first and second crane operations that a stirring event occurred.

**5.** The information processing device according to claim 1, wherein

the deposition information generating section (62) is configured to
generate the deposition information by (i) plotting the Z coordinate value, which indicates the height of the waste, for each set of XY coordinates which set indicates a position on a plane inside the pit (21) and (ii) associating each set of XYZ coordinates which set indicates a spatial position inside the pit with a degree of stirring of a waste block associated with the set of XYZ coordinates, and
in a case where the event determining section (61) has determined at least either the heap slide or the stirring event, move a waste block in the decrease area to the increase area in the deposition information and update the degree of stirring in the deposition information which degree of stirring is of a waste block resulting from the moving.

**6.** An information processing method that is carried out by an information processing device (4) for monitoring waste deposited inside a pit (21),
the method comprising:

obtaining a plurality of pieces of measurement data (71) that is generated by a height measuring device (13) each time the height measuring device (13) carries out measurement and that indicates a height of the waste,
wherein the height measuring device (13) is a

three-dimensional measurement device for measuring a surface shape of the waste deposited inside the pit,
the information processing method further comprises:

comparing (i) first measurement data generated as a result of previous measurement with (ii) second measurement data generated as a result of later measurement, both the first measurement data and the second measurement data being in a form of three-dimensional measurement data indicative of a shape of the waste,
determining one or more sets of XY-coordinate values as one or more respective height change areas in the pit (21) at each of which one or more sets the height of the waste which height is indicated with a Z-coordinate value has been changed by not less than a predetermined value,
determining an event related to movement of the waste that occurred in each of the one or more determined height change areas; and
on a basis of the event determined, generating deposition information indicative of a state of how the waste deposited inside the pit (21) has been stirred.

**Patentansprüche**

**1.** Informationsverarbeitungs-Vorrichtung (4) zum Überwachen von in einer Grube (21) abgelagertem Abfall, wobei die Informationsverarbeitungs-Vorrichtung (4) umfasst:

einen Abschnitt (60) zum Erfassen von Daten, der so konfiguriert ist, dass er eine Vielzahl von Messungs-Daten (71) erfasst, die von einer Höhenmessvorrichtung (13) immer dann erzeugt werden, wenn die Höhenmessvorrichtung (13) Messung ausführt, und die eine Höhe des Abfalls angeben,
wobei
die Höhenmessvorrichtung (13) eine Vorrichtung für dreidimensionale Messung ist, mit der eine Oberflächenform des in der Grube abgelagerten Abfalls (21) gemessen wird,
und die Informationsverarbeitungs-Vorrichtung (4) des Weiteren umfasst:

einen Abschnitt (61) zum Bestimmen eines Ereignisses, der konfiguriert ist zum:

Vergleichen (i) als ein Ergebnis früherer Messung erzeugter erster Messungs-Daten mit (ii) als ein Ergebnis späterer Messung erzeugten zweiten Messungs-Daten, wobei sowohl die ersten Messungs-Daten als auch die zweiten Messungs-Daten in Form dreidimensionaler Messungs-Daten vorliegen, die eine Form des Abfalls angeben,
Bestimmen eines Satzes oder mehrerer Sätze von XY-Koordinatenwerten als einen oder mehrere jeweiligen/jeweilige Höhenänderungs-Bereich/Bereiche in der Grube (21), wobei an jedem von dem einen Satz oder den mehreren Sätzen die Höhe des Abfalls, die mit einem Z-Koordinatenwert angezeigt wird, um nicht weniger als um einen vorgegebenen Wert geändert worden ist,
Bestimmen eines Ereignisses, das sich auf Bewegung des Abfalls bezieht, die in jedem von dem einen oder den mehreren Höhenänderungs-Bereich/Bereichen aufgetreten ist; und

einen Abschnitt (62) zum Erzeugen von Ablagerungs-Informationen, der so konfiguriert ist, dass er auf Basis des bestimmten Ereignisses Ablagerungs-Informationen (74) erzeugt, die einen Zustand dahingehend angeben, wie der in der Grube (21) abgelagerte Abfall gerührt worden ist.

**2.** Informationsverarbeitungs-Vorrichtung nach Anspruch 1, wobei

der Abschnitt (60) zum Erfassen von Daten so konfiguriert ist, dass er die Vielzahl von Messungs-Daten (71) in einem Intervall erfasst, das kürzer ist als ein Intervall, in dem das Ereignis in der Grube (21) auftritt,
der Abschnitt (61) zum Bestimmen eines Ereignisses so konfiguriert ist, dass er immer dann, wenn der Abschnitt (60) zum Erfassen von Daten ein Element von Messungs-Daten erfasst, das Ereignis bestimmt, indem er die (i) als letzte erfassten zweiten Messungs-Daten mit den (ii) als vorletzte erfassten ersten Messungs-Daten vergleicht, und
der Abschnitt (62) zum Erzeugen von Ablagerungs-Informationen so konfiguriert ist, dass er die Ablagerungs-Informationen immer dann aktualisiert, wenn der Abschnitt (61) zum Bestimmen eines Ereignisses das Ereignis bestimmt.

**3.** Informationsverarbeitungs-Vorrichtung nach Anspruch 1, wobei

der Abschnitt (60) zum Erfassen von Daten so konfiguriert ist, dass er (i) Kran-Daten (72), die einen Verlauf von Betätigung eines Krans angeben, der den Abfall in die Grube (21) befördert, sowie (ii) Einbringungs-Daten (70) erfasst, die einen Verlauf des Einbringens von Abfall in die Grube (21) angeben, und
der Abschnitt (61) zum Bestimmen eines Ereignisses dann, wenn

(i) ein Abnahme-Bereich, in dem die Höhe des Abfalls verringert wurde, und ein Zunahme-Bereich um den Abnahme-Bereich herum, in dem die Höhe des Abfalls vergrößert wurde, unter dem einem oder den mehreren Höhenänderungs-Bereich/en bestimmt worden sind,
(ii) die Kran-Daten (72) keinen Verlauf von Betätigung des Krans in dem einen oder den mehreren Höhenänderungs-Bereich/en innerhalb eines ersten Messungs-Zeitrahmens aufweisen, der sich von einem ersten Messungs-Datum/einer ersten Messungs-Uhrzeit, zu dem/der die ersten Messungs-Daten erzeugt wurden, bis zu einem zweiten Messungs-Datum/einer zweiten Messungs-Uhrzeit erstreckt, zu dem/der die zweiten Messungs-Daten erzeugt wurden, und
(iii) die Einbringungs-Daten (70) keinen Verlauf von Einbringen von Abfall in den einen oder die mehreren Höhenänderungs-Bereich/e innerhalb des ersten Messungs-Zeitrahmens aufweisen, konfiguriert ist zum:

Feststellen, dass in dem einen oder den mehreren Höhenänderungs-Bereich/en innerhalb des ersten Messungs-Zeitrahmens ein Halden-Abrutschen stattgefunden hat, wobei es sich bei dem Halden-Abrutschen um ein Ereignis handelt, bei dem sich Abfall ohne Eingriff von außen von einer hohen Position zu einer niedrigen Position bewegt.

**4.** Informationsverarbeitungs-Vorrichtung nach Anspruch 1, wobei der Abschnitt (61) zum Bestimmen eines Ereignisses konfiguriert ist zum:

Feststellen einer ersten Kran-Betätigung von Aufnehmen von Abfall in dem Abnahme-Bereich durch den Kran, wenn durch Vergleich zwischen den ersten Messungs-Daten und den zweiten Messungs-Daten der Abnahme-Bereich bestimmt worden ist und die Kran-Daten (72) einen Verlauf von Betätigung des Krans in dem Abnahme-Bereich innerhalb des ersten Messungs-Zeitrahmens aufweisen,

Feststellen einer zweiten Kran-Betätigung von Fallenlassen des aufgenommenen Abfalls in dem Zunahme-Bereich durch den Kran, wenn durch Vergleich zwischen den zweiten Messungs-Daten und nach den zweiten Messungs-Daten erzeugter dritter Messungs-Daten der Zunahme-Bereich bestimmt worden ist und die Kran-Daten (72) einen Verlauf von Betätigung des Krans in dem Zunahme-Bereich innerhalb eines zweiten Messungs-Zeitrahmens aufweisen, der sich von dem zweiten Messungs-Datum/der zweiten Messungs-Uhrzeit bis zu einem dritten Messungs-Datum/einer dritten Messungs-Uhrzeit erstreckt, zu dem/der die dritten Messungs-Daten erzeugt wurden, und
Feststellen, dass ein Rühr-Ereignis stattgefunden hat, auf Basis der ersten und der zweiten Kran-Betätigung.

**5.** Informationsverarbeitungs-Vorrichtung nach Anspruch 1, wobei der Abschnitt (62) zum Erzeugen von Ablagerungs-Informationen konfiguriert ist zum:

Erzeugen der Ablagerungs-Informationen durch (i) grafisches Darstellen des Z-Koordinatenwertes, der die Höhe des Abfalls angibt, für jeden Satz von XY-Koordinaten, der eine Position auf einer Ebene innerhalb der Grube (21) angibt, sowie (ii) Verknüpfen jedes Satzes von XYZ-Koordinaten, der eine räumliche Position innerhalb der Grube angibt, mit einem Grad von Rühren eines Abfallblocks, der mit dem Satz von XYZ-Koordinaten verknüpft ist, und
Bewegen eines Abfallblocks in dem Abnahme-Bereich in den Zunahme-Bereich in den Ablagerungs-Informationen sowie Aktualisieren des Grades von Rühren in den Ablagerungs-Informationen, der ein aus dem Bewegen resultierender Grad von Rühren eines Abfallblocks ist, wenn der Abschnitt (61) zum Bestimmen eines Ereignisses entweder das Halden-Abrutscherereignis oder das Rührereignis festgestellt hat.

**6.** Informationsverarbeitungs-Verfahren, das von einer Informationsverarbeitungs-Vorrichtung (4) zum Überwachen von in einer Grube (21) abgelagertem Abfall durchgeführt wird,
wobei das Verfahren umfasst:

Erfassen einer Vielzahl von Messungs-Daten (71), die von einer Höhenmessvorrichtung (13) immer dann erzeugt werden, wenn die Höhenmessvorrichtung (13) Messung ausführt, und die eine Höhe des Abfalls angeben,
wobei
die Höhenmessvorrichtung (13) eine Vorrichtung für dreidimensionale Messung zum Messen einer Oberflächenform des in der Grube ab-

gelagerten Abfalls ist, und
das Informations-Verarbeitungsverfahren des Weiteren umfasst:

Vergleichen (i) als ein Ergebnis früherer Messung erzeugter erster Messungs-Daten mit (ii) als ein Ergebnis späterer Messung erzeugten zweiten Messungs-Daten, wobei sowohl die ersten Messungs-Daten als auch die zweiten Messungs-Daten in Form dreidimensionaler Messungs-Daten vorliegen, die eine Form des Abfalls angeben,
Bestimmen eines Satzes oder mehrerer Sätze von XY-Koordinatenwerten als einen oder mehrere jeweiligen/jeweilige Höhenänderungs-Bereich/Bereiche in der Grube (21), wobei an jedem von dem einen Satz oder den mehreren Sätzen die Höhe des Abfalls, die mit einem Z-Koordinatenwert angezeigt wird, um nicht weniger als um einen vorgegebenen Wert geändert worden ist,
Bestimmen eines Ereignisses, das sich auf Bewegung des Abfalls bezieht, die in jedem von dem einen oder den mehreren Höhenänderungs-Bereich/Bereichen aufgetreten ist; und
Erzeugen von Ablagerungs-Informationen, die einen Zustand dahingehend angeben, wie der in der Grube (21) abgelagerter Abfall gerührt worden ist, auf Basis des bestimmten Ereignisses.

**Revendications**

**1.** Dispositif de traitement d'information (4) pour surveiller des déchets déposés à l'intérieur d'une fosse (21), le dispositif de traitement d'information (4) comprenant :

une section d'obtention de données (60) configurée pour obtenir une pluralité d'éléments de données de mesure (71) qui sont générées par un dispositif de mesure de hauteur (13) chaque fois que le dispositif de mesure de hauteur (13) met en oeuvre une mesure et qui indiquent une hauteur des déchets,
dans lequel le dispositif de mesure de hauteur (13) est un dispositif de mesure en trois dimensions pour mesurer une forme de surface des déchets déposés à l'intérieur de la fosse (21),
le dispositif de traitement d'information (4) comprend en outre :

une section de détermination d'événement (61) configurée pour :
comparer (i) des premières données de mesure générées en tant que résultat d'une mesure antérieure avec (ii) des deuxièmes données de mesure générées en tant que résultat d'une mesure ultérieure, le jeu de premières données de mesure et le jeu de deuxièmes données de mesure se présentant tous deux sous la forme de données de mesure en trois dimensions indicatives d'une forme des déchets ;
déterminer un ou plusieurs jeux de valeurs de coordonnées XY en tant qu'une ou plusieurs zones de modification de hauteur respectives dans la fosse (21), un ou plusieurs jeux pour lesquels la hauteur des déchets, laquelle hauteur est indiquée à l'aide d'une valeur de coordonnée Z, a été modifiée de pas moins qu'une valeur prédéterminée ; et
déterminer un événement lié au déplacement des déchets qui s'est produit au niveau de chacune des une ou plusieurs zones de modification de hauteur déterminées ; et

une section de génération d'information de dépôt (62) configurée pour, sur la base de l'événement déterminé, générer une information de dépôt (74) indicative de la façon dont les déchets déposés à l'intérieur de la fosse (21) ont été brassés.

**2.** Dispositif de traitement d'information selon la revendication 1, dans lequel :

la section d'obtention de données (60) est configurée pour obtenir la pluralité d'éléments de données de mesure (71) au niveau d'un intervalle plus court qu'un intervalle au niveau duquel l'événement se produit à l'intérieur de la fosse (21) ;
la section de détermination d'événement (61) est configurée pour, chaque fois que la section d'obtention de données (60) obtient un élément des données de mesure, déterminer l'événement en comparant (i) les deuxièmes données de mesure, qui ont été obtenues le plus récemment, avec (ii) les premières données de mesure qui ont été obtenues juste avant ; et
la section de génération d'information de dépôt (62) est configurée pour mettre à jour l'information de dépôt chaque fois que la section de détermination d'événement (61) détermine l'événement.

**3.** Dispositif de traitement d'information selon la reven-

dication 1, dans lequel :

la section d'obtention de données (60) est configurée pour obtenir (i) des données d'appareil de levage (72) indicatives d'un historique de fonctionnement d'un appareil de levage qui transporte les déchets à l'intérieur de la fosse (21) et (ii) des données d'amenée (70) indicatives d'un historique d'amenée de déchets à l'intérieur de la fosse (21) ; et
la section de détermination d'événement (61) est configurée pour, dans le cas où

(i) une zone de diminution dans laquelle la hauteur des déchets a diminué et une zone d'augmentation, au voisinage de la zone de diminution zone d'augmentation, dans laquelle la hauteur des déchets a augmenté ont été déterminées parmi les une ou plusieurs zones de modification de hauteur ;
(ii) les données d'appareil de levage (72) ne comportent pas un historique de fonctionnement de l'appareil de levage dans les une ou plusieurs zones de modification de hauteur à l'intérieur d'un premier laps de temps de mesure qui s'étend depuis des premières date et heure de mesure auxquelles les premières données de mesure ont été générées jusqu'à des deuxièmes date et heure de mesure auxquelles les deuxièmes données de mesure ont été générées ; et
(iii) les données d'amenée (70) ne comportent pas un historique d'amenée de déchets dans les une ou plusieurs zones de modification de hauteur à l'intérieur du premier laps de temps de mesure ;

déterminer qu'un glissement d'amoncellement s'est produit dans les une ou plusieurs zones de modification de hauteur à l'intérieur du premier laps de temps de mesure, le glissement d'amoncellement étant un événement de déplacement des déchets depuis une position haute jusqu'à une position basse sans intervention artificielle.

**4.** Dispositif de traitement d'information selon la revendication 1, dans lequel :
la section de détermination d'événement (61) est configurée pour :

dans le cas où la zone de diminution a été déterminée par l'intermédiaire d'une comparaison entre les premières données de mesure et les deuxièmes données de mesure et où les données d'appareil de levage (72) comportent un historique de fonctionnement de l'appareil de levage dans la zone de diminution à l'intérieur du premier laps de temps de mesure, déterminer une première opération d'appareil de levage consistant en ce que l'appareil de levage saisit les déchets dans la zone de diminution ;
dans le cas où la zone d'augmentation a été déterminée par l'intermédiaire d'une comparaison entre les deuxièmes données de mesure et des troisièmes données de mesure générées après les deuxièmes données de mesure et où les données d'appareil de levage (72) comportent un historique de fonctionnement de l'appareil de levage dans la zone d'augmentation à l'intérieur d'un second laps de temps de mesure qui s'étend depuis les deuxièmes date et heure de mesure jusqu'à des troisièmes date et heure de mesure auxquelles les troisièmes données de mesure ont été générées, déterminer une seconde opération d'appareil de levage consistant en ce que l'appareil de levage fait tomber les déchets saisis dans la zone d'augmentation ; et
déterminer, sur la base des première et seconde opérations d'appareil de levage, qu'un événement de brassage s'est produit.

**5.** Dispositif de traitement d'information selon la revendication 1, dans lequel :
la section de génération d'information de dépôt (62) est configurée pour :

générer l'information de dépôt en (i) traçant la valeur de coordonnée Z, laquelle indique la hauteur des déchets, pour chaque jeu de coordonnées XY, lequel jeu indique une position sur un plan à l'intérieur de la fosse (21), et en (ii) associant chaque jeu de coordonnées XYZ, lequel jeu indique une position spatiale à l'intérieur de la fosse, à un degré de brassage d'un bloc de déchets associé au jeu de coordonnées XY ; et dans le cas où la section de détermination d'événement (61) a déterminé au moins soit le glissement d'amoncellement, soit l'événement de brassage, déplacer un bloc de déchets dans la zone de diminution jusqu'à la zone d'augmentation selon l'information de dépôt et mettre à jour le degré de brassage dans l'information de dépôt, lequel degré de brassage concerne un bloc de déchets suite à son déplacement.

**6.** Procédé de traitement d'information qui est mis en oeuvre par un dispositif de traitement d'information (4) pour surveiller des déchets déposés à l'intérieur d'une fosse (21),
le procédé comprenant :

l'obtention d'une pluralité d'éléments de données de mesure (71) qui sont générées par un dispositif de mesure de hauteur (13) chaque fois que le dispositif de mesure de hauteur (13) met en oeuvre une mesure et qui indiquent une hau-

teur des déchets,
dans lequel le dispositif de mesure de hauteur (13) est un dispositif de mesure en trois dimensions pour mesurer une forme de surface des déchets déposés à l'intérieur de la fosse,
le procédé de traitement d'information comprend en outre :

la comparaison (i) de premières données de mesure générées en tant que résultat d'une mesure antérieure avec (ii) des deuxièmes données de mesure générées en tant que résultat d'une mesure ultérieure, le jeu de premières données de mesure et le jeu de deuxièmes données de mesure se présentant tous deux sous la forme de données de mesure en trois dimensions indicatives d'une forme des déchets ;
la détermination d'un ou de plusieurs jeux de valeurs de coordonnées XY en tant qu'une ou plusieurs zones de modification de hauteur respectives dans la fosse (21), un ou plusieurs jeux pour lesquels la hauteur des déchets, laquelle hauteur est indiquée à l'aide d'une valeur de coordonnée Z, a été modifiée de pas moins qu'une valeur prédéterminée ;
la détermination d'un événement lié au déplacement des déchets qui s'est produit au niveau de chacune des une ou plusieurs zones de modification de hauteur déterminées ; et
sur la base de l'événement déterminé, la génération d'une information de dépôt indicative de la façon dont les déchets déposés à l'intérieur de la fosse (21) ont été brassés.

FIG. 1

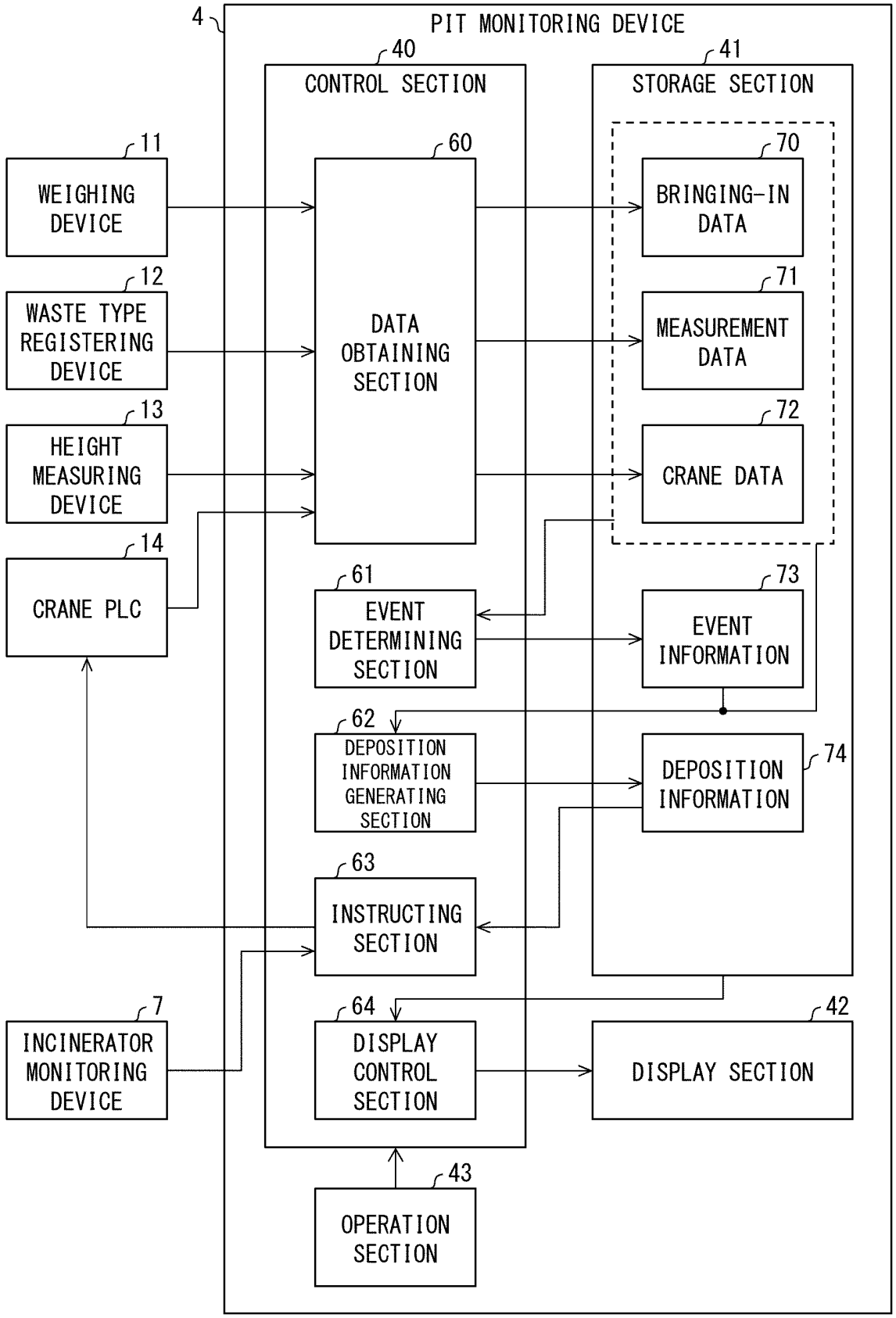

4
PIT MONITORING DEVICE
40
CONTROL SECTION
41
STORAGE SECTION
11
WEIGHING DEVICE
12
WASTE TYPE REGISTERING DEVICE
13
HEIGHT MEASURING DEVICE
14
CRANE PLC
60
DATA OBTAINING SECTION
70
BRINGING-IN DATA
71
MEASUREMENT DATA
72
CRANE DATA
61
EVENT DETERMINING SECTION
73
EVENT INFORMATION
62
DEPOSITION INFORMATION GENERATING SECTION
74
DEPOSITION INFORMATION
63
INSTRUCTING SECTION
7
INCINERATOR MONITORING DEVICE
64
DISPLAY CONTROL SECTION
42
DISPLAY SECTION
43
OPERATION SECTION

FIG. 2

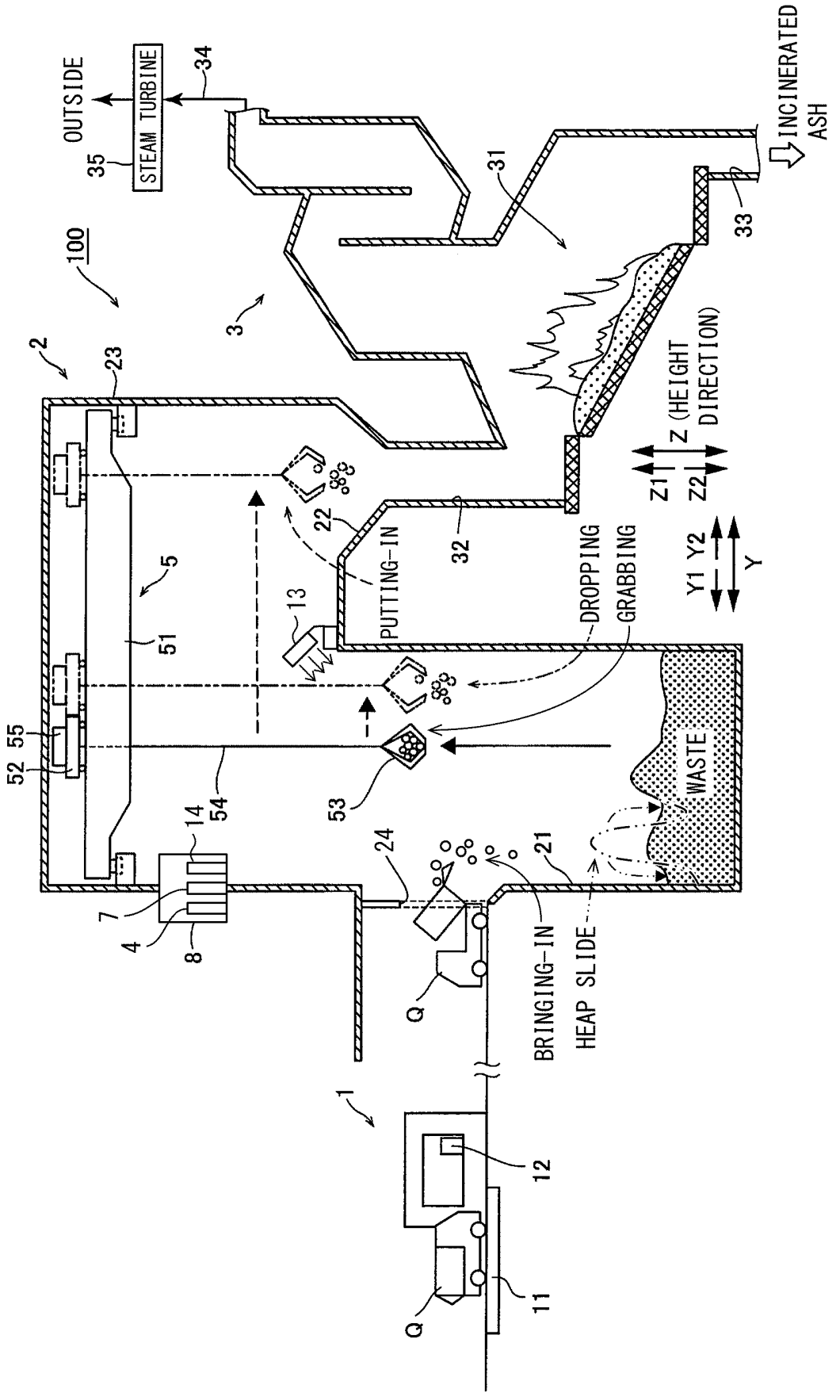

OUTSIDE
STEAM TURBINE
34
35
100
2
23
3
31
33
INCINERATED ASH
Z (HEIGHT DIRECTION)
Z1
Z2
Y1 Y'2
Y
22
PUTTING-IN
32
DROPPING
GRABBING
13
5
51
52 55
54
53
WASTE
14
7
4
8
24
21
Q
BRINGING-IN
HEAP SLIDE
1
12
11

FIG. 3

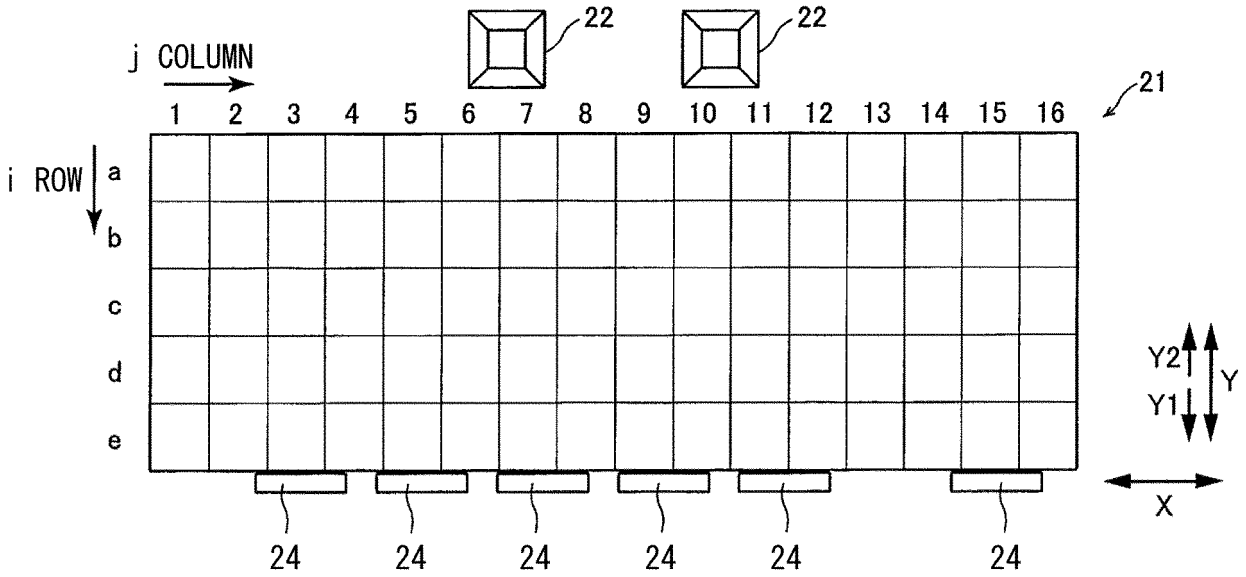
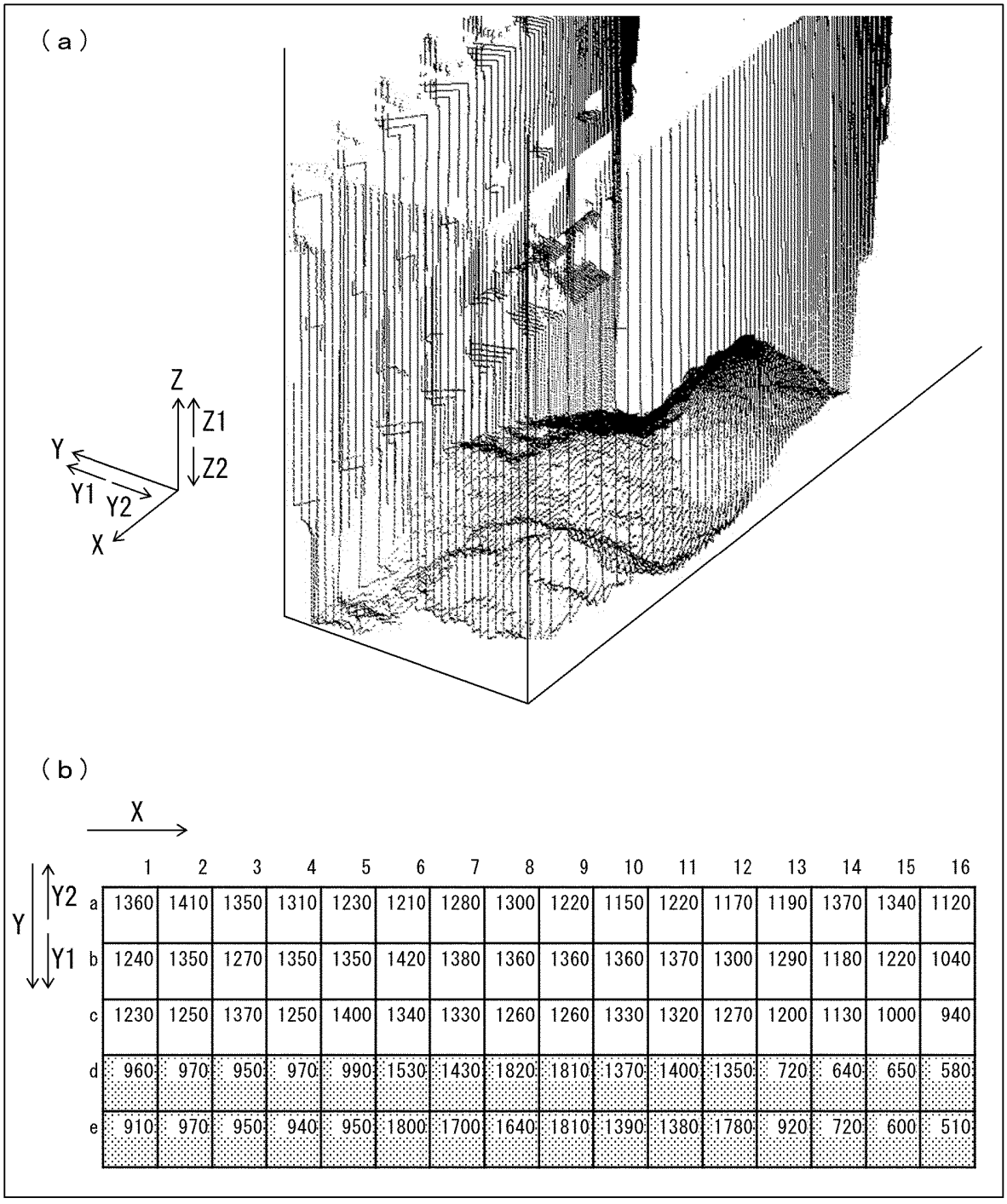



FIG. 4

| BRINGING-IN DATE AND TIME | BRINGING-IN ENTRANCE | BRINGING-IN AMOUNT | WASTE TYPE |
|---|---|---|---|

FIG. 5




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a | 1360 | 1410 | 1350 | 1310 | 1230 | 1210 | 1280 | 1300 | 1220 | 1150 | 1220 | 1170 | 1190 | 1370 | 1340 | 1120 |
| b | 1240 | 1350 | 1270 | 1350 | 1350 | 1420 | 1380 | 1360 | 1360 | 1360 | 1370 | 1300 | 1290 | 1180 | 1220 | 1040 |
| c | 1230 | 1250 | 1370 | 1250 | 1400 | 1340 | 1330 | 1260 | 1260 | 1330 | 1320 | 1270 | 1200 | 1130 | 1000 | 940 |
| d | 960 | 970 | 950 | 970 | 990 | 1530 | 1430 | 1820 | 1810 | 1370 | 1400 | 1350 | 720 | 640 | 650 | 580 |
| e | 910 | 970 | 950 | 940 | 950 | 1800 | 1700 | 1640 | 1810 | 1390 | 1380 | 1780 | 920 | 720 | 600 | 510 |

FIG. 6

| DRIVING DATE AND TIME | X COORDINATE | Y COORDINATE | BUCKET WEIGHT |
|---|---|---|---|

FIG. 7

(a)

| OCCURRENCE DATE AND TIME | DETERMINATION RESULT | | INCREASE AREA | INCREASE AMOUNT | DECREASE AREA | DECREASE AMOUNT |
|---|---|---|---|---|---|---|
| | EVENT | CRANE OPERATION | | | | |

(b)

| OCCURRENCE DATE AND TIME | DETERMINATION RESULT | | ... |
|---|---|---|---|
| | EVENT | CRANE OPERATION | |
| 2017/5/15 11:56 | BRINGING-IN | — | ... |
| 2017/5/15 12:00 | STIRRING | GRABBING | ... |
| 2017/5/15 12:02 | | DROPPING | ... |
| 2017/5/15 12:03 | TAKING-OUT | GRABBING | ... |
| 2017/5/15 12:08 | | GRABBING | ... |

FIG. 8

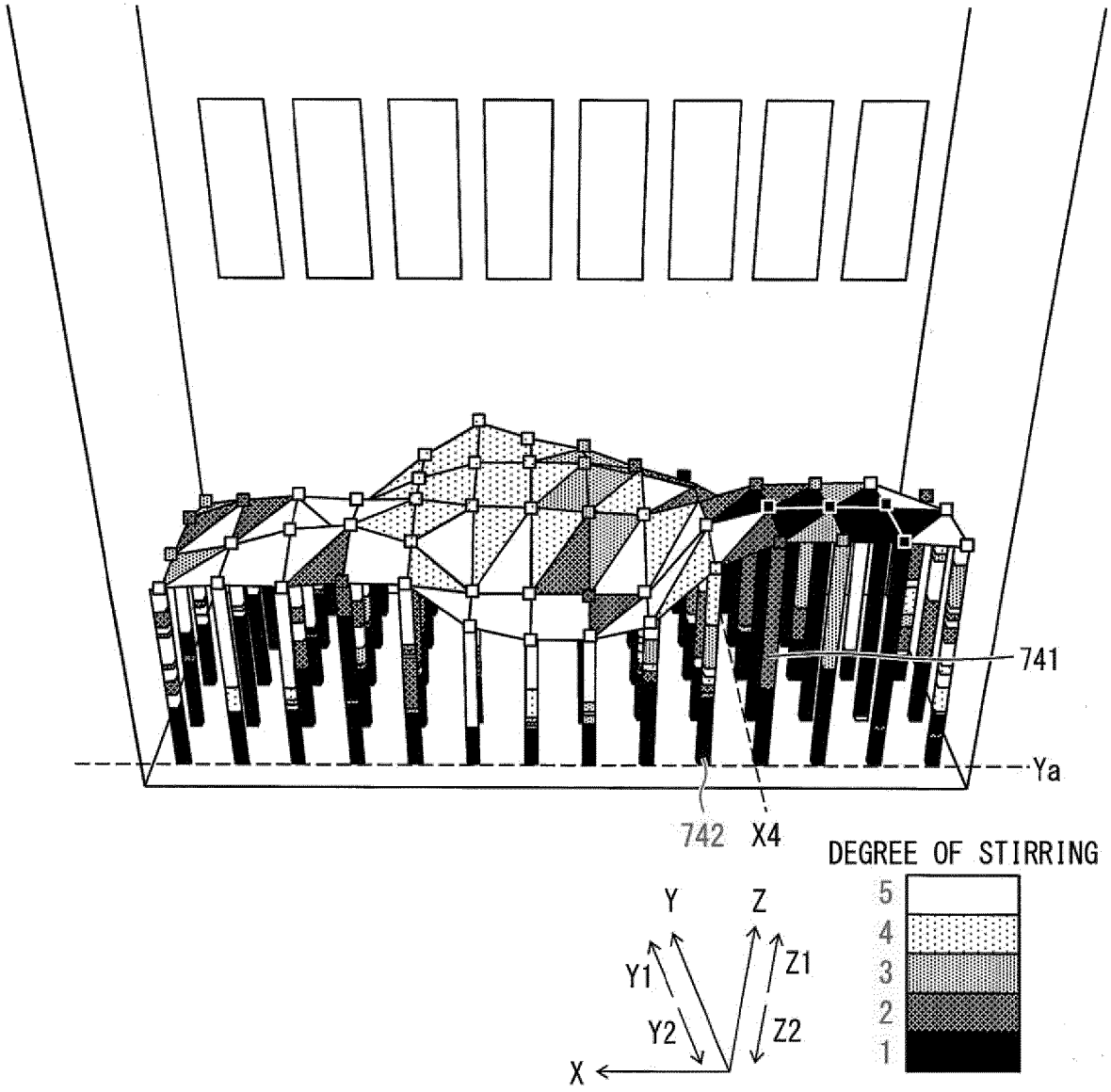


FIG. 9

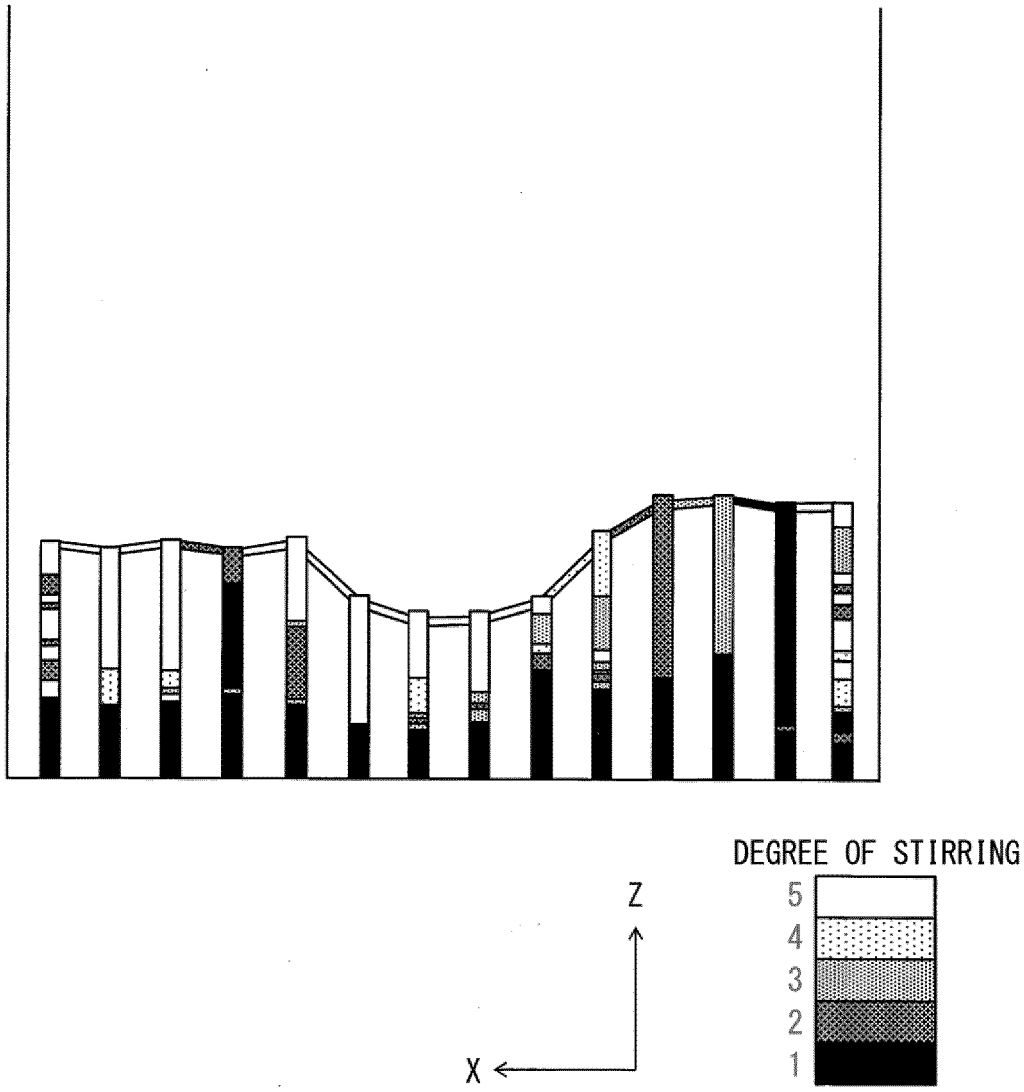


FIG. 10

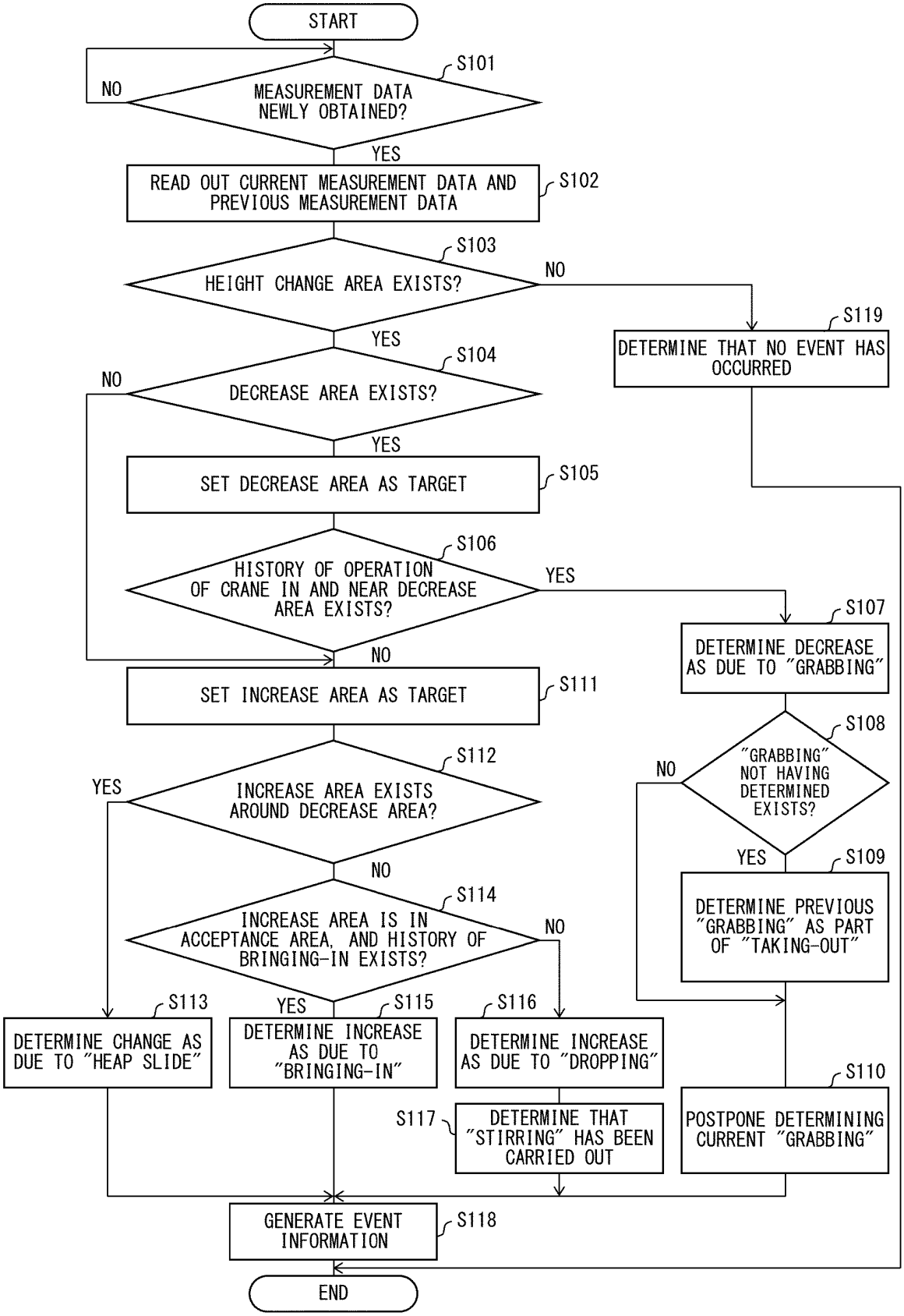

START
S101
MEASUREMENT DATA NEWLY OBTAINED?
NO
YES
READ OUT CURRENT MEASUREMENT DATA AND PREVIOUS MEASUREMENT DATA
S102
S103
HEIGHT CHANGE AREA EXISTS?
NO
YES
S119
DETERMINE THAT NO EVENT HAS OCCURRED
S104
DECREASE AREA EXISTS?
NO
YES
SET DECREASE AREA AS TARGET
S105
S106
HISTORY OF OPERATION OF CRANE IN AND NEAR DECREASE AREA EXISTS?
YES
NO
S107
DETERMINE DECREASE AS DUE TO "GRABBING"
SET INCREASE AREA AS TARGET
S111
S108
"GRABBING" NOT HAVING DETERMINED EXISTS?
NO
YES
S109
DETERMINE PREVIOUS "GRABBING" AS PART OF "TAKING-OUT"
S112
INCREASE AREA EXISTS AROUND DECREASE AREA?
YES
NO
S114
INCREASE AREA IS IN ACCEPTANCE AREA, AND HISTORY OF BRINGING-IN EXISTS?
NO
YES
S113
DETERMINE CHANGE AS DUE TO "HEAP SLIDE"
S115
DETERMINE INCREASE AS DUE TO "BRINGING-IN"
S116
DETERMINE INCREASE AS DUE TO "DROPPING"
S117
DETERMINE THAT "STIRRING" HAS BEEN CARRIED OUT
S110
POSTPONE DETERMINING CURRENT "GRABBING"
GENERATE EVENT INFORMATION
S118
END

FIG. 11

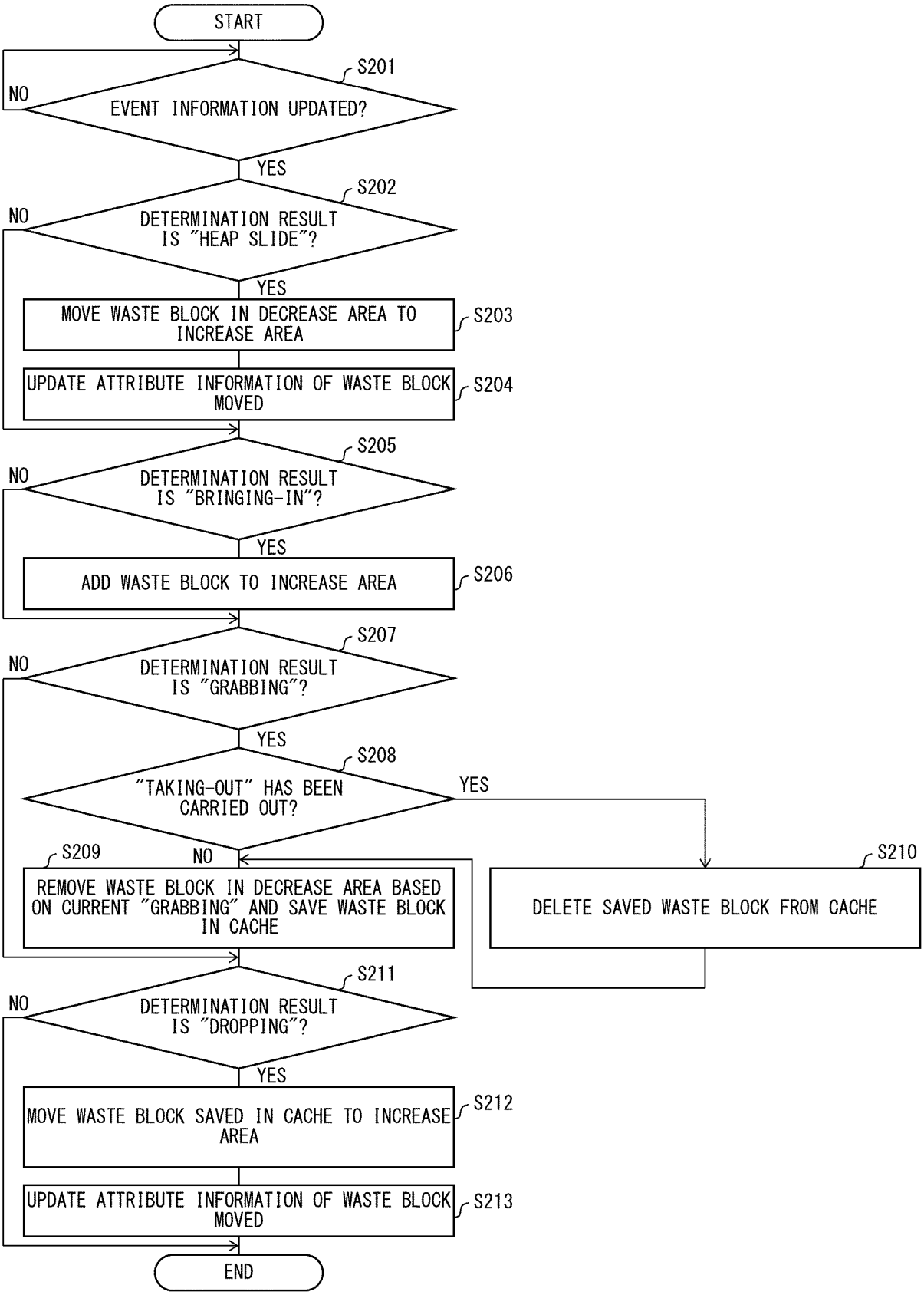
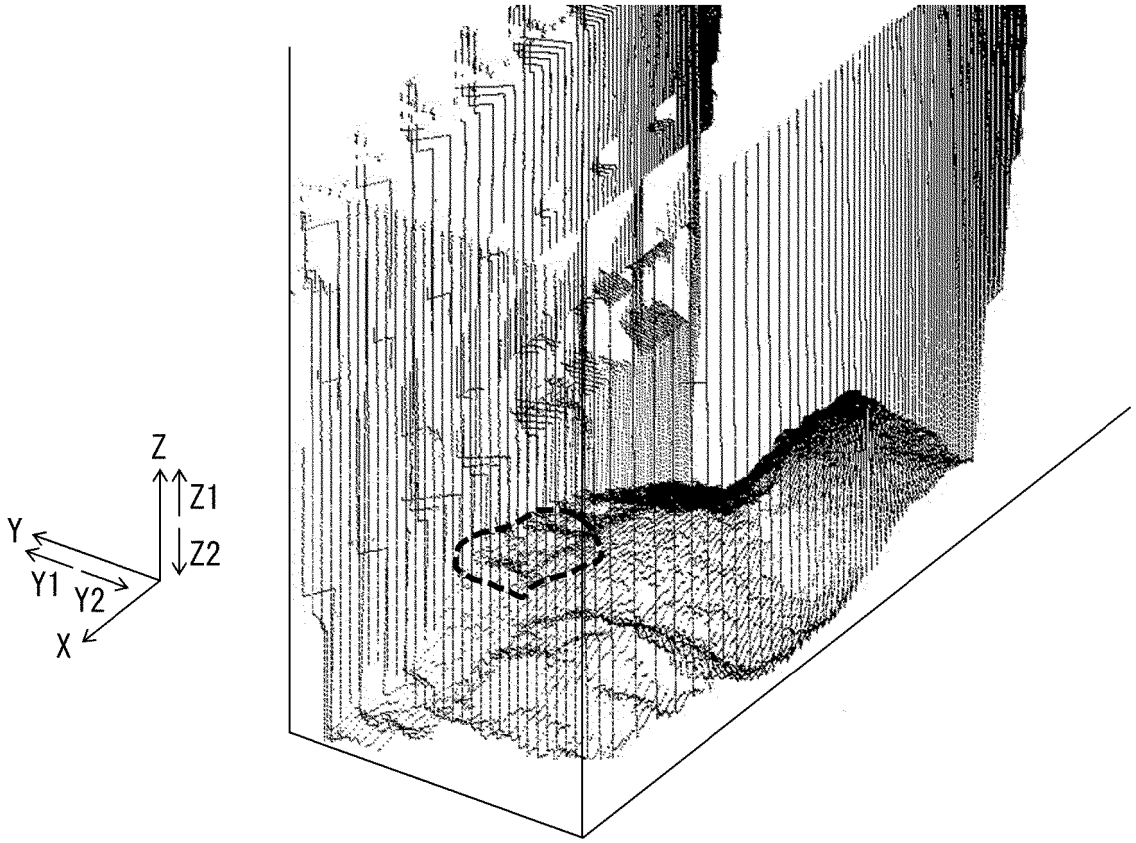

START
S201
EVENT INFORMATION UPDATED?
NO
YES
S202
DETERMINATION RESULT IS "HEAP SLIDE"?
NO
YES
MOVE WASTE BLOCK IN DECREASE AREA TO INCREASE AREA
S203
UPDATE ATTRIBUTE INFORMATION OF WASTE BLOCK MOVED
S204
S205
DETERMINATION RESULT IS "BRINGING-IN"?
NO
YES
ADD WASTE BLOCK TO INCREASE AREA
S206
S207
DETERMINATION RESULT IS "GRABBING"?
NO
YES
S208
"TAKING-OUT" HAS BEEN CARRIED OUT?
YES
NO
S209
REMOVE WASTE BLOCK IN DECREASE AREA BASED ON CURRENT "GRABBING" AND SAVE WASTE BLOCK IN CACHE
S210
DELETE SAVED WASTE BLOCK FROM CACHE
S211
DETERMINATION RESULT IS "DROPPING"?
NO
YES
MOVE WASTE BLOCK SAVED IN CACHE TO INCREASE AREA
S212
UPDATE ATTRIBUTE INFORMATION OF WASTE BLOCK MOVED
S213
END

FIG. 12



## REFERENCES CITED IN THE DESCRIPTION

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